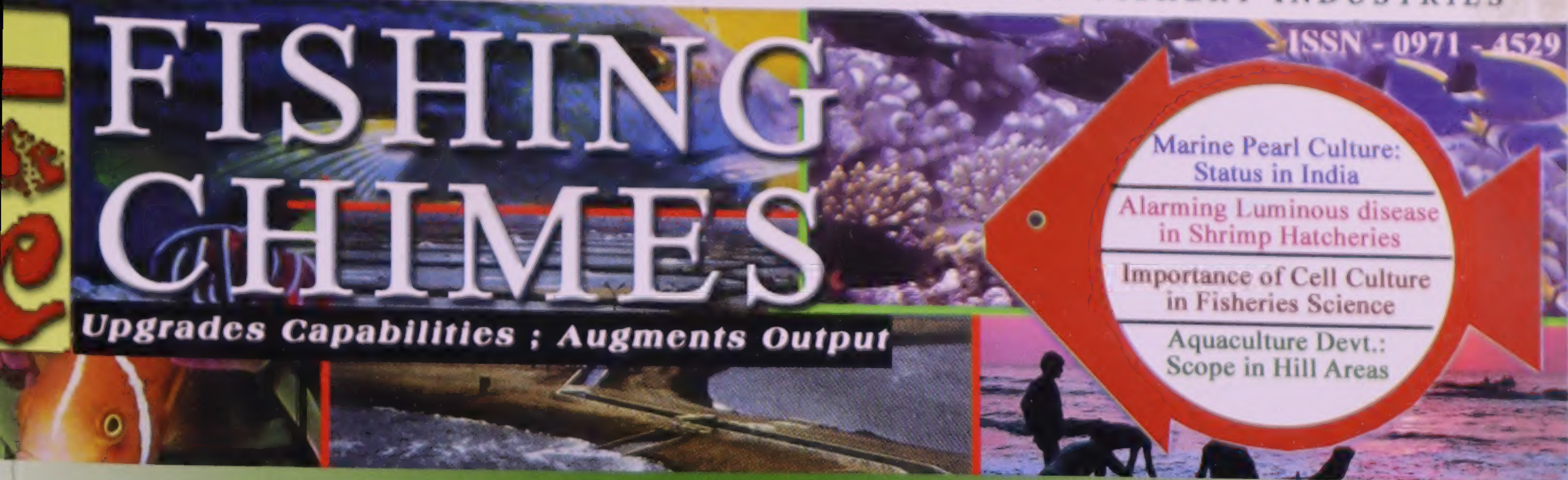
JOURNAL DEVOTED TO THE DEVELOPMENT OF FISHERY INDUSTRIES



FISHING CHIMES

Upgrades Capabilities ; Augments Output

ISSN - 0971 - 4529

JULY 2001

21 No.4 | National Fisheries Journal of India : Estd 1981 | Rs 65

FISHING CHIMES

ESTABLISHED : 1981

A monthly journal devoted to the development of Fishery Industries

Vol. 21 No. 4 — **National Fisheries Journal of India** — **July 2001**

CONTENTS

Thank you readers for your growing support

Editor and Publisher
J.V.H. Dixitulu

Fishing Chimes
Chimes House
Sector - 12, Plot - 176, M.V.P. Colony
Visakhapatnam - 530 017, India
Tel : (0891) 543171, 539319
Fax : 91 - 891 - 539142
Email:
Fishingbells@satyammail.com
Website :
WWW.fishingchimes.com

Printed by
G. Ramakrishna
Raamakrishna Printers Pvt. Ltd.,
49-24-5, Sankaramatham Road
Madhuranagar, Visakhapatnam - 16
Tel : (0891) 798072

Registered as a Journal in India
(No. 37750/81)

ANNUAL SUBSCRIPTION
Inland Rs. 780/-
Foreign US $ 74/-

Letter

Sir,

With reference to the article by Mr. A. Sreenivasan entitled 'Stagnating Reservoir Fish Production of India', published in your April 2001 issue, I have a comment to make on what has been mentioned in the last paragraph.

The author says in this para : "The examples of success stories of cooperatives mentioned in this article (for e.g., Mettur, RTADC, Matsya Vikas Nigam etc.) should spur the departments to organize such cooperatives for reservoir fishery".

I would like to point out that 'Matsya Vikas Nigam' means Fishing Development Corporation in Hindi. The M.P. Fisheries Development Corporation (M.P.F.D.C.) has now become M.P. Matsya Mahasangh (Sahkari) Maryadit. It is supposed to be a co-operative federation but it retains the entire staff of MPFDC. MPFDC has a poor track record in Tawa and this is probably no different from the preformance of several other state fisheries development corporations.

An article on our co-operative was published in July 2000 issue of your Journal entitled "Success Story of Tawa Matsya Sangh".

The author has apparently referred to our co-operative federation, because on Page 42 second column last line of the same article, he has mentioned "In Tawa reservoir of M.P. the fish production increased from 136.7 mt in 1990-91 to 344.4 mt in 1998-99 because of management by Fishermen's co-operatives". I appreciate the gracious recognition of our performance, which is the result of hard work of member fishermen.

Fishing in Tawa Reservoir is being carried out by Tawa Displaced Tribal Fish Production and Marketing co-operative Federation Ltd (Tawa Matsya Sangh), from 1997. As the name shows this is a co-operative body.

The following tables clarify the comparative performances of the Corporation and Tawa Co-op Federation. →

Contd from Col. 1

Comparative Production Figures of Tawa Reservoir

a) M.P. Fisheries Development Corporation

Year	Production (mt)	Yield (ha)	Fish seed Stocking (lakhs/nos)	No. of Fishermen working	Work days	Total income Rs/lacs
90-91	130.69	10.75	20.67	120	-	6.10
91-92	146.01	12.05	24.85	110	-	7.32
92-93	88.67	7.30	16.43	116	-	4.57
93-94	84.42	6.95	27.48	177	-	4.92
94-95	176.18	15.50	17.96	220	221	11.20
Average	125.19	10.31	21.48	149	-	6.82

b) Tawa Co-op Federation

Year	Production (mt)	Yield (ha)	Fish seed Stocking (lakhs/nos)	No. of Fishermen working	Work days	Total income Rs/lacs
96-97 3 mths	93.229	7.68	-	379	85	11.09
97-98	245.811	20.24	26.13	393	267	30.44
98-99	344.375	28.350	27.90	400	257	47.15
99-2000	393.163	32.370	29.47	479	262	52.12
2000-01	327.175	26.94	32.19	477	250	47.46

Kesla, Hoshangabad Dt., M.P.

M. Yadav
Sahayak Prabandhak

Doctorate Awarded to FSI Scientist

L. Ramalingam

Mr. L. Ramalingam, Sr. Fisheries Scientist, Visakhapatnam Base of Fishery Survey of India has been awarded Ph.D. degree by the Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu for his thesis on "Population Identification, Biology, Biochemical Composition, Yield and Utilisation of Saddle Grunt, *Pomadasys maculatum* (Bloch, 1797) (Pisces : Haemulidae) in Indian EEZ", during February 2001. The results of his findings are presented in 11 chapters and the investigation has yielded detailed information on the Population Identification, Food and Feeding, Maturation and Spawning, Length-Weight relationship, Age and Growth, Proximate Composition, Yield and Utilisation of the species *Pomadasys maculatum*. His study aimed at determining the geographically differentiated samples by employing statistical allometry equations, testing all the parameters simultaneously i.e., by permutation combination technique and the research findings revealed the existence of four distinct groups of population of *Pomadasys maculatum* in Mumbai, Kochi, Chennai and Visakhapatnam waters of Indian EEZ.

Since existence of independent stocks of *Pomadasys maculatum* is evident on the basis of the findings in Mumbai, Kochi, Chennai and Visakhapatnam waters, intensive fishing at any other locality will not affect the fishing of this species. The research work was carried out under the meticulous guidance of Dr. M. Narayanan, Reader, Department of Zoology. St. Xavier's College, Palayamkottai, Tamil Nadu.

FISHING CHIMES

Estd : 1981

Visakhapatnam, India

Vol. 21 No. 4
July 2001

FISHING CHIMES

10th July 2001 marks the Birth of Special Fish Farmers' Day

Major carps were successfully induced to breed for the first me at Angul in Orissa on 10th July 1957 through dministration of pituitary harmone by Prof (Dr.) Hiralal haudhuri. This pioneering work over years has led to quaplosion in the country principally through quality major arp seed production and supplies to fish farmers for culture om hundreds of hatcheries (based on induced breeding) that prang up in the country, in the wake of the technology eveloped by the professor.

In order to commemorate this day on which such a omentous breakthrough that dramatically transformed the sh culture sector in India took place, the Government of India ecently declared 10 July as Special Fish Farmers' Day. The rst Special Fish Farmers' day after the declaration was elebrated at various centres all over the country by fish rmers and fishers on 10 July 2001.

The declaration is directly related to a grateful recognition y the government, of the unique and solid impact of the reakthrough, which has altered in near totality the redominantly capture-oriented inland fishery of India into a ulture-based one. The event elevated fish culture over years the status of a recognised industrial activity which has since een playing a growing role in strengthening rural economy nd in the national aqua product export endeavour. It ighlights the signal importance of aquafarmers in stepping p aquaproduction.

It was left to Ms. Nita Chowdhury, a senior officer of the ndian Administrative service (one of the few officers of the ervice, known to have a dedicatory slant towards fisheries evelopment) and also the Union Joint Secretary (Fisheries), take cognisance of the unique significance of 10 July in the istory of culture fishery development of India. The momentous mport of the event dawned on her at the time when she onferred the first Hiralal Chaudhuri Fish Farmer Gold Medal, stituted by Jayashree Charitable Trust, at a well attended unction held in December 2000 at CICFRI, Barrackpore. She pparently perceived the catalytic role the celebration of 0th July as Fish Farmers' Day can play in infusing and ortifying the determination of fish farmers to achieve ustainable higher levels of culture fish production and in ugmenting the incomes and prosperity of fish farmers, backed y the opportunities the annual celebration would provide for hem to reflect upon their past performance, and to evolve easures for further improvements in their farming profession. o much so, she initiated the landmark proposal, which, by virtue of its importance, could earn the well-deserved approval of the Prime Minister to the proposal. This approval has empowered farmers and all others concerned to observe 10th July every year as Special Fish Farmers' Day.

The lead celebration of the Day took place at the Central Institute of Fisheries Education, Mumbai on 10 July 2001. Mr. Nitish Kumar, Union Minister for Agriculture inaugurated the celebration, in which Mr. Ananda Rao Devakote and Mrs. Meenakshitai Patel, Cabinet Minister and State Minister respectively of the Government of Maharashtra, Ms. Nita Chowdhury, Union Joint Secretary (Fisheries), Dr. K. Gopakumar, Deputy Director General (Fisheries), ICAR, Dr. S. Ayyappan, Director and Vice-Chancellor, Central Institute of Fisheries Education, among others, participated. They spoke in laudatory terms about the significant contributions made by fish farmers in raising aquaproduction of the country and thereby adding substantially to aqua exports. A large number of farmers and fishers participated in

Dr. S. Ayyappan honouring Mr. Nitish Kumar with a shawl

Ms. Nita Chowdhury lighting the second wick of the inaugural lamp after formal inaugural lighting by Agri. Min. Next to her is Mrs. Meenakshitai Patel.

Ms. Nita Chowdhury, the Architect of Special Fish Farmers' Day speaking on the occasion.

Contd. page 7

the function, which was celebrated with gaity, fervour and enthusiasm. The second annual Hiralal Chaudhuri Best Fish Farmer Award of Jayashree Charitable Trust was conferred on this occasion on Mr. Ch. Srikanth, a progressive aqua-farmer specialising and contributing with distinction to scampi seed production and scampi culture in Nellore district of Andhra Pradesh by Mr. Nitish Kumar, Union Minister of Agriculture and Railways.

The Special Fish Farmers' Day was celebrated on 10th July in almost all the States. In Kerala this was accompanied by a Workshop on 'Fish Farming Problems and Solutions', inaugurated by the Fisheries Minister, Prof. K.V. Thomas. Mr. Thomas said the Government was planning to hold a discussion on the proposed changes to be brought about in aquaculture and fish marketing sector, involving all agencies in this field, in the presence of the Chief Minister, Mr. A.K. Antony on August 27 at Cochin. In Orissa, West bengal, Bihar and other states too there were similar celebrations, with participation by the fisheries ministers concerned, farmers and officials.

A comprehensive report on the celebrations at the Central Institute of Fisheries Education and in various states will be published in the earliest possible issue of Fishing Chimes.

Tenth Plan Fisheries Schemes Refreshingly Forward-looking

The successive fisheries plans were all along dominated by certain repetitive schemes, despite the fact that quite a few of them such as those related to established seed production and culture activities, mechanisation of fishing vessels, statistics etc. Considering that the need for renewing such schemes, plan after plan, atleast in the later five year plans, has been tapering out, a new orientation seems to have given to the tenth plan fisheries schemes.

In this background, it is refreshing to know that the Fisheries Division of the Union Department of Animal Husbandry and Dairying ushered in certain path-breaking schemes, refreshingly different and aimed at achieving a new set of objectives in tune with the emerging priorities and needs of the present and the future.

One major line of action envisaged in the 10th plan is the induction of the vast inland culture fishery sector of the country into aqua-product export basket, while also simultaneously envisaging the establishment of a domestic fish marketing network. This single initiative alone is capable of adequately transferring the fisheries developmental sector into a throbbing activity in the inland zones that can result in a higher level of fish production, higher level of exports, employment etc. When culture of species such as giant freshwater prawn and tiger shrimp is propelled into the numerous tanks and ponds and reservoirs located in the guts of the country, and into the vast saline lands now lying waste in the North-Western part of the country with the needed infrastructural development, a major change in the socio-economic life of the weaker sections of the society would manifest itself in the zones. The export endeavour will add to the national foreign exchange earnings in a substantial manner. The creation of the domestic fish marketing network that would spread far and wide will take fish within the reach of the common man. At the same time, this network would enhance opportunities to exporters to bargain for higher rates from importers, and the fish farmers would also be able to realise higher incomes, because of export demand.

Another major plank envisaged is the mounting of a scheme for the exploitation high sea pelagic fisheries resources such as Tuna and also the deep sea resources such as lobster in the Indian EEZ around the mainland and around Andamans. The introduction of this scheme fills a demand in that direction by the industries. The implementation of such a scheme would counteract the present overtures of Taiwan, a distant water fishing nation to exploit to their advantage the fishery resources of Indian EEZ unhindered. The presence of the Indian Tuna and other fishing fleets introduced under the scheme will result in a near total discouragement to foreign vessels to fish in our waters. At the same time, the nation would stand to earn considerable foreign exchange through exports.

A noticeable flaw in the past planning has been the lack of focus on mariculture including sea cage culture. This lapse can be expected to be overcome by implementing well drawn schemes proposed under the plan, aimed at promoting mariculture and sea-cage culture. The development of this activity would be a boon to the coastal fishers for augmenting their incomes and to upgrade their standards of living, and would also promote export-oriented production.

The development of reservoir fisheries has all along been undertaken in a perfunctory manner. A cardinal proposition in the 10th Plan is to take up in a systematic way the development of capture-culture balance in the various reservoirs of the country in an integrated manner and apparently with a cluster approach to provide the needed infrastructure facilities for production and supply of seed for stocking, for harvesting the produce, for its transport to and storage at centralised units and channelising the same to feed the proposed domestic marketing network and for exports.

The introduction of suitable organisational mechanisms for the development of all major types of resources such as reservoirs, coastal fisheries etc., on the lines of FFDAs and BFDAs is envisaged under the 10th plan. This reform will enable the various projects to gain momentum and run on a sound-footing.

In the past two decades, we have been observing a major depletion of fisheries resources of rivers and coastal sea waters. Not much attention has been paid all along to restore the depleting fisheries wealth of these resources. In the 10th plan it is heartening to note that a programme for ranching of rivers and coastal waters is to be enshrined. This programme would eventually restore the national fisheries heritage. Though late, it is gratifying that such a thoughtful and useful scheme has been included.

The upgradation of traditional fishermen is much talked about, but the talk is not matched by specific schemes or projects aimed at achieving this upgradation in a purposeful manner. The 10th plan is expected to launch organised training programmes for the benefit of traditional fishermen in various fishery activities, linked to the generation/creation of new employment opportunities.

The implementation of the various plans envisaged will be possible only when there is financial support. Accordingly it is envisaged in the plan to introduce a conducive and structured financing policy for the development of the various projects in the plan, taking into account the unique characteristics of the fishery sector.

The Union Fisheries Division and the Planning Commission deserves to be congratulated for identifying the future lines of fishery development so thoughtfully and purposefully.

Tiger Shrimp Hatcheries need supplies of disease-free Brooders

India has around 130 tiger shrimp hatcheries all along its coastline. Most of these hatcheries are unable to produce disease-free post-larvae for the reason that the brooders they have access to, which are from the wild, are infected with dormant white spot virus. Of late, considering the problems involved in producing tiger shrimp nauplii at the hatcheries takes away most of the attention, almost all the hatcheries now secure nauplii stocks from separate nauplii production centres that sprang up at various points. These units supply nauplii to hatcheries, where they are reared into post-larvae.

Efforts at producing 100% WSSV-negative post-larvae at the hatcheries continue with mixed results. Some of the hatcheries have set up their own PCR labs. Several PCR laboratories, central to shrimp culture ponds, have also been set up by MPEDA. Despite this innovation, the occurence of the disease at nauplii and upto post-larvae stage, and in culture ponds continues and the disease could not be controlled to a satisfactory level as yet.

One solution identified to eliminate this menace, is to develop domesticated brood shrimp stocks. In several countries such as New Caledonia, Hawai and a few other states of U.S.A., Australia etc., technology for the production of domesticated brood shrimp stocks has been developed. With the availability of these brooder stocks it has now become a common practice in these countries for broodstock producers to supply domesticated virus-free tiger shrimp brooders to hatchery owners. One advantage enjoyed by these countries is that tiger shrimp is not indigenous to them. The initial stocks were imported by them and the shrimp has established itself in these countries. One precaution they take is to ensure that the tiger shrimps do not escape into wild waters. Emulating the pioneering work done in these countries, in India too the Central Marine Fisheries Research Institute has started a project on for production of domesticated shrimp brooders. It is learnt that the Institute has succeeded in raising broodstock upto the third generation and work is on for raising the fourth generation. It is stated that the brooders have to be developed to atleast the 7th generation for releasing them to the hatcheries for seed production.

The present status, as mentioned above, gives an indication that it may take atleast another 2 or 3 years for CMFRI to supply domesticated brood tiger shrimp stocks to the hatcheries. This means that, during this period of anxiety, the hatcheries would have to continue to put up with heavy losses. In fact, all the hatcheries are now passing through a serious phase of economic losses, particularly because of the falling international prices of exported tiger shrimp. Farmers are not in a position to buy PLs of tiger shrimp from hatcheries at a price not more than 0.12p per piece, because their earnings have come down. Against this, the PL production costs at the hatcheries per piece are stated to be around 0.25p. This kind of financial disadvantage is likely to continue until such time as the international shrimp export prices move up but this is not expected in the foreseeable future.

The sale of domesticated brood shrimp in U.S.A and other countries, where domesticated brood shrimps are produced, has become a routine feature. Advertisements captioned 'Domesticated Shrimp Brood Stock available for sale' are noticed atleast in U.S.A. The advertisements also say that the broodstock supplied is disease-free and used in commercial hatcheries all over the world.

It will take time for the Indian enterprises to reach such a stage. In the meanwhile it will be a very helpful and a purposeful act on the part of the Government to permit import of Tiger Shrimp Brooders by the hatchery owners. For example, these could be imported from Australia where tiger shrimp brooders are produced on a regular basis and sold.

The problem of the Government can be that granting permission for such imports is not feasible as we have no quarantine system to check imported live fishes, shrimps etc. It will be good for the Government to quickly introduce this quarantine system at specified airports and permit import of brood tiger shrimp, through them. Only such of those who have the needed infrastructure for keeping the brooders in healthy live condition and for radiating supplies therefrom to various hatcheries can be considered for granting import permits.

According permission for such imports could be continued until such time as the CMFRI succeeds in raising broodshrimp stocks atleast upto 7th generation. The repercussions of not permitting the imports as suggested could be the continuance of disease regime among cultured shrimp and strengthening adverse reputation among importers of tiger shrimps. Permissions for imports of domesticated shrimp stocks is far more desirable than continuing with the disease menace which has serious implications.

Tuna Tangle

India could not as yet solve the problem of utilising the tuna resources of its EEZ. Consequently, known foreign tuna longlining interests in Indian EEZ are believed to continue to adopt their own methods of exploiting the resources. While the Government approved of a pilot scheme as a prelude to equip two privately owned shrimp trawlers with tuna longlining equipment by providing 50% subsidy thereof and also conceding to take care of all expenses in respect of training of crew, no progress could be made so far. The reason for this is believed to be the overtures of traditional foreign interests to keep to themselves the monopoly over utilisation of tuna resources of Indian EEZ they seem to have. Their intention is believed by several as one aimed at helping the owners in various ways so that they can resume or continue to be in the same status as under the erstwhile Indian charter and joint venture schemes, keeping the operations and marketing under their thumb. An adverse point is that there is evidence to show that, in the past, Taiwanese operators deliberately avoided training of Indian personnel under charter and joint venture schemes.

The fact that India is unable to utilise its tuna resources (with the exception of skipjack around Lakshadweep) despite various efforts over years, leads one to perceive that there can be some invisible external force, to match Indian's own inaction, which is preventing the utilisation of the resources by Indian enterprises. This theory may be construed as based on a wild guess, but the dramatic exit of three Indian companies that operated five longliners from the activity, while saying all along that they were landing good catches; and the recent import of longliners by Indian enterprises involving inverted charter operations, cast a glimmer of doubt that, may be there is some strategy behind. These observations may be in the nature of a flight of imagination, but would certainly deserve examination. Foreign interests cannot be blamed as what they do is to take care of themselves and it is for India to counter the overtures.

The availability of tuna resources in the Indian EEZ is proven. Taiwanese proved this for India. Their known interest to secure a footing in the Indian EEZ to enable them to continue the operations reconfirms this. FSI and CMFRI have been telling time and again about the tuna wealth Indian EEZ holds. Probably India is to be blamed for not utilising the resources, despite availability. India also appears to others as not effectively taking care of its rights.

India plays a prominent role in the Indian Ocean Tuna Commission. This role can be diversified for the development of integrated tuna fishing operations in the Indian EEZ on a sound and enduring basis, in collaboration with a reliable foreign tuna fishing nation that is friendly towards India and having expertise in tuna longlining. On hind sight, it looks as if the bringing in of the pilot scheme as referred to above has dislocated the line of action aimed at conversion of existing trawlers to undertake tuna longlining too and made the industry to lose time as is now continuing to happen. The scuttling of the pilot scheme has given time for other interests to ensure that India remains where it was in the tuna sector.

Indian tuna stocks, as in other EEZs are exposed to predation by whales. It is estimated that fishes etc., 4 to 5 times of global fish production are consumed by whales. They eat 1-4% of their body weight per day. In other words, compared to global fish production of 90 million t, whales consume 360 to 450 million t, of which tunas are a good part. Because of India not catching tuna of its own EEZ two things are happening; one is that foreign interests exploit the resource and Indian enterprises have practically no chance of catching them, as at present. The other is that whales get them.

In the light of the foregoing appraisal, it is imperative that the Government of India tackles the situation with all the attention it deserves and not allow the situation to drift any further, as it would be advantageous to others, chiefly Taiwanese interests. The need now is not for a pilot scheme but for launching a major integrated project to exploit and utilise tuna resources of Indian EEZ for national benefit. The scheme may have to be drawn up in such a way that we do not get trapped into undesirable situations once again. There are countries such as Australia, New Zealand, USA and several others, whose expertise in integrated monofil tuna longlining operations can be tapped in a manner that the country acquires all round expertise without being dominated but conceding such benefits as justified to the collaborating country. One aspect is certain. We are not in a position to build up expertise in tuna sector on our own. We have to depend on others and it will be in national interest to work towards achieving this, pledging some of our interests for the best possible use until we acquire the needed expertise, as was done in 1950s in respect of shrimp trawling.

Sri Lanka aspiring to be Indian Ocean Tuna Shipment Centre

Sri Lanka is yearning to be become tuna shipment centre in the Indian Ocean, according to a report in FNI. The prerequisite to realise this objective is to attract vessels with tuna catches for unloading at this centrally located island in the Indian ocean. Sri Lanka lies along the great year-around Indian Ocean migratory route for tuna, which originates near Madagascar, travels north-east and then returns south after reaching the Arabian Sea.

The island's Ministry of Fisheries and Aquatic Resources Development is encouraging Sri Lankan fishing companies to go into joint ventures with overseas operators, as the national fisheries industry does not have enough funds to buy deep-water tuna ships.

Such Joint venture companies must catch tuna outside Sri Lanka's EEZ and the catch has to be landed at Mutwal Fisheries Harbour or the Port Authority Harbour in Galle, 72 miles south of Colombo. (*Source* : FNI).

Status of Marine Pearl Culture in India

Mohan Joseph Modayil and V. Kripa
Central Marine Fisheries Research Institute
PO Box. 1603, Kochi 682014, Kerala.

Pearls, the gems from the sea, have been admired and adored as symbols of beauty, power and love. In the *Shastras* pearls are recommended as a charm. Ancient *Ayurvedic* and *Unani* physicians have used powdered pearls in their medicines. Natural pearls are formed when an irritant like a grain of sand is swept into an oyster and is lodged within its flesh where it gets coated by a micro-thin layer of nacre, a silvery substance that is about 90 percent calcium carbonate. The oyster continues to coat the irritant, layer by layer, transforming the irritant into the shining pearl, the nature's miracle. The majority of natural pearls are irregularly shaped or blemished.

Pearl-producing molluscs have the shiny mother-of-pearl layer on the inner side of its shell capable of producing a pearl. Pearl as a jewel is produced by only a few species of bivalves. Among the bivalves the prime species of pearl oysters producing the finest pearls are *Pinctada fucata*, *Pinctada margaritifera* and *Pinctada maxima*. The winged oyster, *Pteria penguin* produces pearls rarely. The window pane oyster *Placuna placenta* produces seed pearls which are porcelaneous and translucent. These are used for their medicinal properties and are not considered as gems. Other bivalves like the marine mussels, *Perna* sp and several species of the giant clam *Tridacna* sp and several others occasionally produce porcelaneous pearls without mother- of- pearl.

Apart from the bivalves, some gastropods available in Indian seas such as the abalone, *Haliotis* spp and the queen conch *Strombus gigas* are also known to produce pearls. Tooth or tusk shapes are distinctive characteristics of many natural abalone pearls. One of the first recorded abalone pearls are in the crown of the Buddhist Goddess of Mercy (installed in 748 A.D) located in the Sangastsu-do of the temple Todai-ji in Japan. The queen conch is an icon of the Caribbean culture which produces a porcelaneous pearl that is variable in shape from extremely baroque to very symmetrical and ranges in colour from beige to pink which are sometimes enhanced by a "flame structure" making these unusual gems intensely attractive. Rare non-nacreous whitish cream pearls are reported to have been recovered from one species of cephalopod, *Nautilus pompilius* or the chambered Nautilus. *Haliotis varia*, a small sized abalone, is an intertidal mollusc along the southeast coast but reports of natural abalone pearling in the Indian waters are not available.

The technique for culturing pearls or pearly objects was first developed in the freshwater mussel in China in the 12th century and small outlines of Buddha made of tin were inserted within the fresh water mussel for pearly coating. Marine cultured pearls have their origin in Japan during the second decade of last century. The credit for formulating the pearl sac theory and for developing a cultured pearl industry goes to the Japanese. Till recently the international market for cultured pearl was controlled by them. However, in recent years several other nations have started utilizing their pearl oyster resources and Japan had to lose its monopoly in the production and trade of this precious jewel. In 1998, the world pearl export valued at 396 million US dollars was controlled by French Polynesia (28%), Australia (20%), Japan (14 %) and Indonesia (14%).

Natural Pearl Fishery

Along the Indian coast, natural beds of pearl oysters known as *paars* in Gulf of Mannar and Palk Bay and *Khaddas* in Gulf of Kutch were frequently exploited by fishers to harvest the natural pearls. The Indian pearl fisheries were equated at one time with the Persian Gulf fisheries for the production of the finest oriental pearls. From 1663 to this date, in 338 years, there have been only 38 pearl fisheries rounds. During 1955 - 61, the annual (restricted season) number of pearl oysters fished in the Gulf of Mannar ranged from 1.18 million (1957) to 21.48 (1958), the average being 10.85 million oysters per fishery per season. In the Gulf of Kutch, the fisheries used to be conducted every 3 or 4 years, seven in all, with an average annual production of about 19,000 oysters between 1950 and 1967. Unfortunately this activity dwindled gradually and virtually came to a halt in southeast coast around 1960s. The collections from Gulf of Kutch also ebbed out in 1966. Descriptions about the pearls harvested are few. Reports about the 1958 pearling indicate that fine pearls of 7 carat and baroque / blisters up to 23 carats were also collected. The main reason for the decline of natural pearling has been identified as paucity of oysters. One peculiarity of Indian pearl industry was that only the pearls were utilised, while the shell and the meat were discarded. In some of the major pearl producing nations, the early pearl industry relied on mother-of-pearl shell mainly used for buttons and inlay work. In India though the pearl beds have recovered slightly from their earlier barrenness, they have not yet recouped to a stage to support pearl fishery.

Pearl fisheries were practised for several centuries in many parts of the world. The most important pearl fisheries contributing to 85% of the world production of natural pearls had existed in the Persian Gulf. The pearling areas were Kuwait, Bahrain, Dubai, Bushire, Charak and Lengeh in the Persian Gulf and Muscat in the Gulf of Oman. After 1952, Bahrain did not conduct any pearl fishery as the divers were gainfully employed in oil companies. Among the Arab nations, Kuwait

still relies on natural pearls even though the probability of landing a commercial sized pearl is one out of 4,200. The Sri Lankan pearl fisheries were also once famous as those of the Persian Gulf, producing the true oriental pearls. However these pearls were generally small. Pearls from the Philippines, ranging in colour from white to bronzy-greenish black, were also famous especially in Singapore, Paris and London. Pearl fishery was practised in the Gulfs of Panama and California, the major species being *Pinctada margaritifera*. The famous Tararequi pearls were from the Gulf of Panama. Other famous areas of Pearl fisheries were in the islands of Cubgua and Margarita in the Caribbean from where the light yellow coloured pear shaped Peregrina pearl weighing 134 grains was fished.

Pearl fisheries used to be conducted for the shells of gold-lip or silver lip (*Pinctada maxima*) and black-lip (*Pinctada margaritifera*) which were commercially valuable as raw material for the manufacture of buttons and for the mother-of-pearl inlay work. In French Polynesia approximately one in 15,000 black-lipped oysters gave a natural south sea black pearl. However, this industry declined dramatically with the introduction of plastic buttons. In Japan, Australia, French Polynesia and China, the pearl industry recovered with the introduction of pearl culture in 1950s. Even after the development of pearl production technique, natural pearl fishery is conducted in many nations. In 1996-97 about 96,510 natural pearls were exported from Australia.

Pearl Oyster Resources and Pearl Culture in India

Among the six species of Pearl oysters recorded in the Indian waters, *Pinctada fucata* (Fig.1.) is the main species, which is used for pearl culture in the mainland. In the Andaman and Nicobar waters the black lip pearl oyster *Pinctada margaritifera* (Fig.2.) is available but is not utilised currently for pearl production. James Hornell, the dedicated British biologist in India, had observed that there were 72 pearl banks, known as *paars*, mainly located between 8°20'N and 9°00'N lat within 78°15'E and 78°25'E long. However, these *paars* became unproductive and barren towards the late sixties causing great concern to the pearl industry of the nation. Right at this period, the Indian Council of Agricultural Research supported the planning and implementation of a Scheme on Pearl Culture by the Central Marine Fisheries Research Institute. In 1972, the technology for pearl production, based principally on the Japanese methodology of pearl production, was tried and adopted successfully in respect of the Indian pearl oysters. The technology essentially involves the introduction of an artificial bead along with a secretory mantle tissue into a recipient oyster. The tropical marine environment of India is found conducive to foster the formation of perfectly spherical pearls within a period of 6-8 months. A Well-directed research on pearl culture was organised by the CMFRI in collaboration with the Government of Tamil Nadu. Subsequently, the Department of Fisheries of Tamil Nadu collaborated with the Institute in an *ad-hoc* scheme on pearl culture. During this period multiple production of cultured pearls was achieved and surgical equipment for nucleus implantation was also developed indigenously. This led to the establishment of a pearl farm at Krusadai Island by the Government of Tamil Nadu.

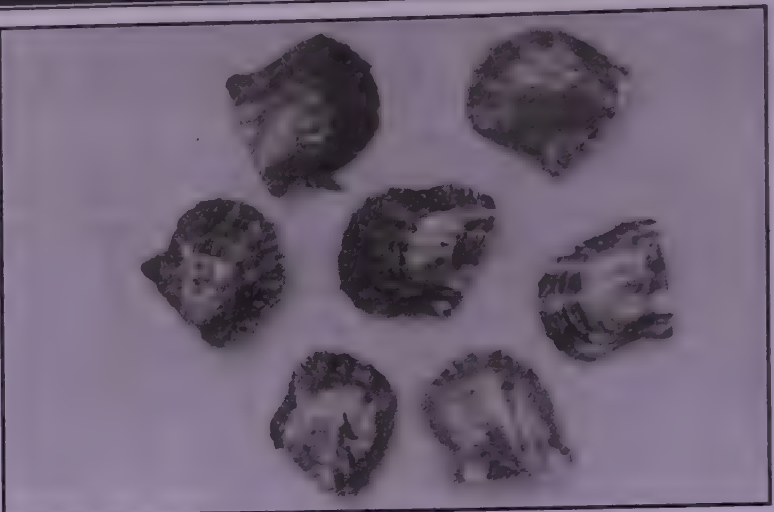


Fig 1. The Indian pearl oyster *Pinctada fucata*

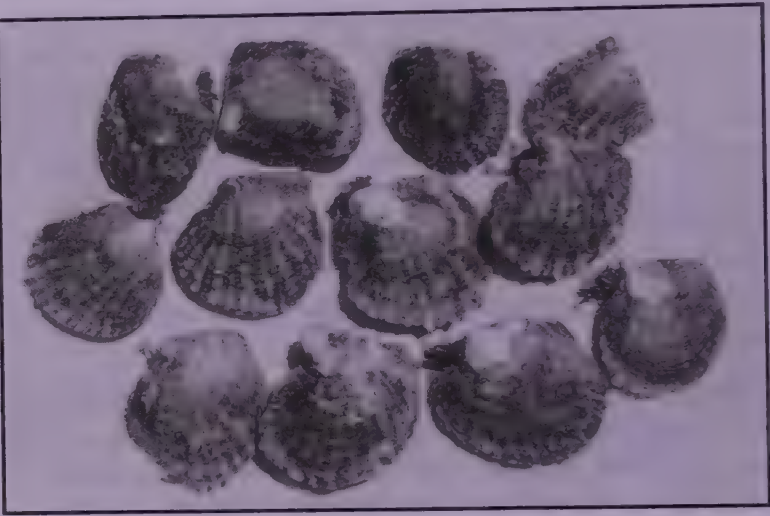


Fig 2. The Black-lip pearl oyster *Pinctada margaritefera* found in the Andaman and Nicobar Islands

Technology for Production of High Quality Marine Pearls and Protocol.

While the technology of pearl oyster farming and pearl production were available indigenously, the natural beds of pearl oysters were 'barren' and there were apprehensions that the technology could not be put to use due to the dearth of pearl oysters. In this context, the CMFRI launched another research project for the production of pearl oysters through hatchery system. The experiments conducted to induce spawning in *Pinctada fucata* through thermal stimulation and variation of pH were successful. In October 1981, the pearl oyster larvae were reared successfully to veliger stage followed by spat setting. This answered the critical predicament of paucity of resource for carrying out cultured pearl production. The flagellate *Isochrysis galbana* is used as larval feed and the mean size of spat at setting, which is usually after 22 days, is 330 x 330 Mm. The hatchery reared spat are transferred at an early stage (about 4 mm) to iron (6 mm dia) framed boxes covered with nylon mesh and lined on the inside with a fine

Selection of Site
- Salinity above 30 parts per thousand
- Good phytoplankton production
- Mild / moderate current
- Low siltation
- Depth 2 to 3 m and above

⇓

Selection of oysters

Oysters of 1.5 to 2.0 years, weight > 25 g, Reproductive stage : spent / resting, free from polychaete/ sponge boring, and infections

⇓

Conditioning
- Arranging oysters with their hinge upwards
- Narcotisation by sprinkling menthol

⇓

Preparation of graft tissue
- Select healthy non narcotised oyster
- Cut mantle into thin strips of 5 x 0.5 cm
- Remove mucous and muscle, cut into 2-3 mm squares
- Keep cells live by adding Azumin in sterilised SW

⇓

Implantation
- Mounting oysters in the stand with valves upwards
- Making incision at the right place and placing the graftpiece
- Placing the sterilized nucleus on the graftmantle piece

⇓

Convalescence
- Placing the implanted oysters in fresh seawater with mild circulation
- Maintaining water quality by water exchange
- Shifting the healthy implanted oysters to natural beds

meshed synthetic fabric. They are kept until they can be transferred to square cages with rigid mesh. When the spat measure 25-30 mm dorsoventrally, they are grown in iron cages (40 x 40 x 10 cm) webbed with 15 mm mesh nylon webbing.

The CMFRI thus became the nerve centre for pearl culture research and development in India. With the technology and capability to produce large number of spat in the hatchery, a programme on sea ranching to revive the pearl beds was launched in 1985. Pearl oyster spat were reared in the hatchery (Fig.4) until they reached 3 - 5 mm and then transferred to the harbour. When they attained a size of 10 - 15 mm, they were allowed to settle on synthetic webbing and taken to *paars* in the Gulf of Mannar where they were lowered to the sea bottom, placed in the hollows and secured to coralline projections. As expected, these young pearl oysters grew in the natural habitat and propagated by spawning, thereby augmenting the pearl oyster population in the *paars*. Subsequent dives made in the beds clearly indicated replenishment of the pearl beds as seen in the number of oysters collected in one diving hour (Fig.5)

Methods of Pearl Farming

1. ***Rack Method***: This method is especially suited for shallow seas. Bamboo or casuarina poles are driven into the bottom spaced 1-2 m apart. These stakes are connected horizontally with poles. The horizontal poles should be above the level of water at high tide. Cages with pearl spat / pearl oyster are hung from these. The pearl farm of CMFRI at Mandapam is a typical rack system (Fig.3)

2. ***Long Line Method***: This method is considered ideal for unprotected open sea conditions. Synthetic rope of 16-20 mm diameter is used for the long line (main line). The main line is supported with 220 litre barrels tied to it, spaced at 5 m. The long line and barrels are anchored in position at either ends using concrete blocks and nylon ropes. Pearl oyster cages are hung from this long line. The experimental pearl oyster unit at Cochin used longline, which showed good performance.

3. ***Raft Culture***: This kind of culture is ideal for open sea conditions which are not rough. Square or rectangular rafts are made with sturdy bamboo or casuarina poles. Buoyancy for the raft is given by tying 5 barrels of 200 litre capacity (metal oil barrel painted with anticorrosive paint or synthetic barrel). Ideal size of the raft is 5x5 m. The rafts are to be positioned at suitable site in the sea using anchors (grapnel, granite, concrete).

Pearl cages are suspended from the raft. At Tuticorin, rafts have been used for pearl farming since 1972.

Transfer of Technology programmes through training

The CMFRI, over the years, has adopted an open policy of providing training targeted at pearl culture not only for Indian nationals but also to foreign technicians who are sponsored through their governments. In consonance with the policy of the Indian Council of Agricultural Research for the transfer of technology, the Institute has been conducting training courses in (1) technology of pearl culture, and (2) technology of hatchery production, since 1976. Apart from these, the Trainers' Training Centre (TTC) and Consultancy Cell of CMFRI also conducts training programmes in pearl culture and SCUBA diving. Officials from the fisheries departments of maritime states and from the Union Territories of Lakshadweep, and the Andaman & Nicobar islands have participated in the training programmes conducted by CMFRI (Fig.6).

Technicians/officials/students sponsored from other countries like Bahrain, Philippines and Belgium have been trained in Pearl culture by CMFRI. In 1991, CMFRI was the venue for the training programme on Pearl culture under the FAO/UNDP/NACA project on Sea Farming in which 26 trainees from nine south-east and Asian countries (Bangladesh, China, Indonesia, Korea, Malaysia, Myanmar, Philippines, Thailand and Vietnam) participated. Recently CMFRI has given a training programme on pearl surgery and seed production to scientific staff from Bahrain upon their request. Yet another programme is being finalised for Sharja Airport Authority at Sharja.

Pearl culture programmes in different maritime states of India

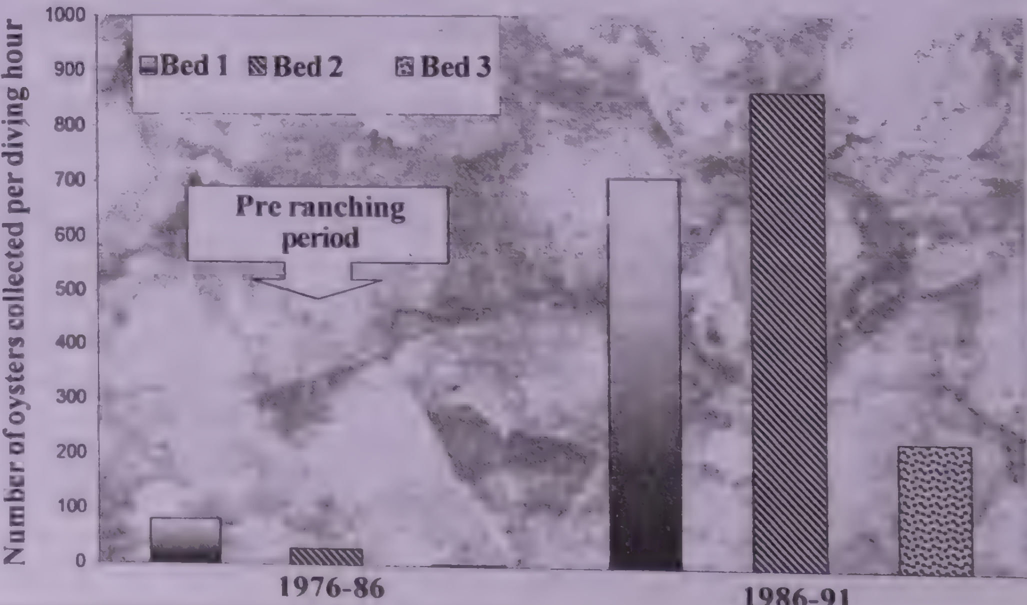
The awareness on pearl culture fostered through the training programme encouraged some maritime states to initiate their own projects on pearl culture. Along the east coast, M/s Tamil Nadu Industrial Development Corporation Ltd (TIDCO) and M/s Southern Petrochemicals Industries Corporation Ltd (SPIC) took up a joint commercial project on pearl production in 1983 with technical know-how from CMFRI. This was a laudable pioneering effort by the government of Tamil Nadu and the industry. In recent years, several private entrepreneurs have started pearl culture in the maritime states of Tamil Nadu and Andra Pradesh. The pearl farm of Indian Tropical Agro Products at Tuticorin was regularly producing marine pearls. One of the significant developments made by these large enterprises was that they were capable of producing pearl spat and which could meet their requirement of implantable oysters without depending on the wild population. Initially, the CMFRI gave technical help to these pearl farmers and supported them to develop their own facilities.

The Department of Fisheries, Gujarat started a research and development

Fig 3. Pearl culture demonstration farm of CMFRI at Mandapam

Fig 4. A view of the larval rearing section in the Pearl oyster hatchery of CMFRI at Tuticorin

Fig 5. Revival of pearl oyster beds along the southwest coast of India after sustained ranching of spat



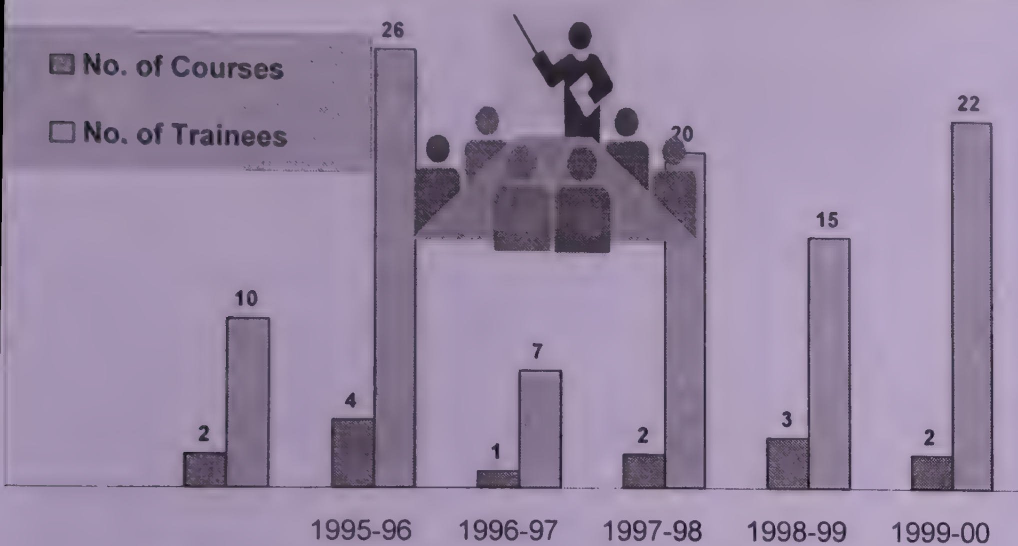


Fig 6. Pearl culture training courses conducted by CMFRI.

programme along the Gujarat coast based on the natural pearl oyster resource. Later, to enhance the depleted stock, the CMFRI offered a helping hand by supplying pearl oyster spat produced in the shellfish hatchery at Tuticorin. With the approval of a World Bank aided project (NATP) on Pearl mariculture, CMFRI has started colloborative programms on transfer of pearl culture programmes in Gujarat and A&N Islands.

Along the Kerala coast, when there was wide spread alarm about the barrenness of Tuticorin *paars*, it was observed that pearl oyster spat could be collected from the natural beds by hanging suitable material from the rafts in the Vizhinjam Bay off this coast. The Government of Kerala executed a pilot project on pearl culture in Vizhinjam in the seventies. However this had to be abandoned due to technical problems. In 1990 s attempts were made again to collect pearl spat from the Vizhinjam Bay. Results of some of the experiments show that spat settlement is profuse in the Bay and these spat can be collected by placing appropriate spat collectors. Growth studies on pearl oysters have also given encouraging results. Feasibility of pearl production along the west coast in the Arabian Sea during the post- and pre-monsoon period (December to May) has been experimentally proved by conducting pearl culture with longlines along the Cochin coast. The formation of nacre was observed to be faster than that seen along the east coast. The quality and lustre of the pearls are comparable to those produced in the natural pearl beds in the Bay of Bengal. However, the strong upwelling currents and the turbid sea was seen to cause disturbance to the farm structure and the oysters during June to September. Commercial ventures in the Arabian Sea are yet to be developed.

The Union Territory of Lakshadweep started a project at Bangaram Island. Recently efforts were made to grow pearl oyster spat produced in the Shellfish Hatchery of CMFRI in the Island ecosystem. The Central Agricultural Research Institute of the ICAR at Port Blair, Andaman & Nicobar Islands, attempted a project on the black-lip pearl oyster. Resource assessment surveys conducted in the 1980s and also during the end of last century have indicated only sparsely populated beds of *Pinctada margaritifera* in these islands.

Pearl Culture as a Village Level Programme

The feasibility of developing pearl culture as a rural upliftment programme with active participation of fishermen was tested in the early nineties at Valinokkam, a small coastal village of Tamil Nadu in southeast coast of India. Twenty-five fishermen of the village were selected and educated about the importance and economic returns of the pearl culture. The fishermen and their family members were involved in all the activities right from the fabrication of grow-out structure to pearl harvest. Part of the pearls produced was given to the fishermen as an incentive (Table.1.) The scope for large scale pearl production through village level community participatory programmes with proper technical and financial support from developmental organisations was clearly indicated by the 'Valinokkam Bay Programme'.

Table.1. Pearl production / culture programme at Valinokkam Bay

Valinokkam Pearl Culture .... A group farming success	
Number of oysters implanted	9414
Total expenditure incurred	Rs.55,000
Total pearls harvested	1849
Pearls distributed to fishermen	250
Revenue earned from sale of pearls	Rs.76,238

Industrialisation of Pearl Culture

Production of high quality pearls by some industrial enterprises has proved beyond doubt the soundness of the technology. Pearl culture is a composite industry, with different components viz., hatchery production, mother oyster culture, pearl production, processing and marketing. Each component is a specialized area requiring appropriate technology, skill and equipment.

The Indian pearl industry has progressed in the recent years. What started as an experiment in 1972, has supported the growth and development of an upcoming industry. While India has been a net importer of raw pearls during the early nineties, from 1996 onwards it has also been able to export cultured pearls, albeit in small quantities.

Recent Research Programmes in Pearl Culture

In 1996, ICAR provided Rs.30 lakhs to CMFRI through a revolving fund to demonstrate the profitability of pearl culture ventures to the industry. At the Mandapam Regional Centre of CMFRI, a pearl oyster hatchery with a production capacity of 2.0 million spat per annum

was set up. The Department of Ocean Development also has financed pearl culture programme of CMFRI. It was during the same period that pearl culture was taken up by large industrial enterprises. To cater to their requirement of pearl oysters, CMFRI provided hatchery produced spat. Even now, pearl oyster spat are regularly supplied to the industry from this project. As a spin-off to this activity, young women in the locality were trained in grafting. Along with this, efforts are being made to develop a technique for pearl production through mantle tissue culture. Preliminary success has been achieved in the culture of some tissues separated from the mantle region. Selective breeding and triploidy productions are also tried. Efforts are also made to develop techniques for on - shore pearl production.

Price structure (in Rs.) of Pearl oysters and Pearls produced in CMFRI

1.	Pearl oyster spat	0.5
2.	Implantable size oyster	4.0
3.	Nucleated Oyster	8.0
4.	A grade pearls (per mg)	1.50
5.	B grade pearls (per mg)	1.00
6.	C grade pearls (per mg)	0.65

After a complete reappraisal of the problems facing the pearl industry, it was decided to tackle these with financial assistance from World Bank, obtained through the National Agricultural Technological Project and in collaboration with different Fisheries Institutions and Agricultural Universities. Currently efforts are on to popularize pearl farming in the coastal villages and also the technology of genetic manipulation relative to quality pearl production. Apart from pearl oysters, preliminary success has also been achieved in half pearl production and development of hatchery technique for raising the abalone *Haliotis varia*. However repeated trials and standardization at each level is required before the technology can be made open for commercial operations.

Chronological events in the development of pearl culture research in India

Significant achievements in Pearl Culture in India

1972	Initiated a project on Pearl Culture at Tuticorin Research Centre of CMFRI along the southeast coast
1973	Production of first cultured marine Pearl in India
1981	First batch of pearl spat produced in Hatchery
1985-87	Initiation of Pearl culture programme in different maritime states
1985-90	Sea ranching of pearl oyster larvae and spat to revive the natural stock
1991	India hosted the FAO/NACA* training programme on Pearl culture at CMFRI --imparting training on pearl culture to trainees from other South, South East and East Asian countries
1993	Village level Pearl production through direct involvement of small-scale fishers. Pearls worth US $ 2178 were produced
1994	Pearl produced along west coast through farming operations in the Arabian Sea
1996-99	Signing of Memorandum of understanding with private entrepreneurs
1997	Development of an indigenous pearl nucleus upto 18 mm size by a private entrepreneur
1998	Initiation of genetic manipulations in pearl culture (tissue culture, selective breeding etc)
1999	Reassertion of technological feasibility of pearl culture technology through successful implementation of Revolving Fund Project sponsored by ICAR at Mandapam Regional Center of CMFRI
1999	National Level Pearl culture programme under National Agricultural Technological Programme. Objectives set to refine the pearl nacre colour, develop indigenous shell bead nuclei and to widen the pearl farming areas. Collaborative programme with other fisheries Research Institutes and Agricultural Universities
2000	Intensification of training programme, also training to candidates from Bahrain in Pearl culture and seed production.
2000	Survey of A&N Island by CMFRI to assess the feasibility of black pearl culture

** Network of Aquaculture Centers in Asia*

Prospects for Marine Pearl Culture in India

The past two decades have witnessed an influx of cultured marine pearls in the international market mainly due to increase in pearl farms in Australia, French Polynesia, Indonesia and Japan. Australia and French Polynesia are the major pearl producing countries and these two nations have different regulatory and marketing systems catering to their pearl industry. Though India was one of the first nations to develop the pearl culture technique, progress of Indian marine pearl industry has been slow due to several reasons. Chronological events in the development of pearl culture as an industry are given above.

To create a profitable marine pearl industry in India concerted effort should be

made by the Research Institutions, Fisheries Departments of different maritime states and the export promotion agencies. The rural development agencies also should join hands with CMFRI to give thrust to transfer of technology programmes of this nature.

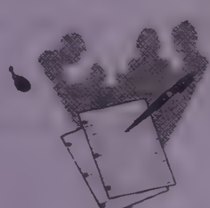
The proposed plan for development of pearl Industry in India

Lack of availability of pearl oysters of implantable size was the main problem two decades back. With the development of hatchery technique for seed production of *Pinctada fucata* this problem has been partly overcome. Pearl culture has been taken up by few large-scale operators along the east coast. However, the lack of a legal framework for providing security to the farm stock is one of the problems faced by the industry. Similarly, the international market for these oriental pearls has not been explored widely. Compared to the South Sea pearls, the Indian oriental pearls are small and this may have its own drawbacks. Hence a clear marketing plan consistant with the quality of these pearls has to be developed.

Pearl culture has been demonstrated to the small-scale fishers of southeast coast (Valinokkam Bay Programme) as an income-generating scheme in 1991. Though the programme was implemented with participation of fishers they have not been able to continue this activity on their own. This is mainly because of lack of finance to set up pearl farms. Moreover, constant motivation and assurance that a pearl culture programme will be profitable is needed to enable the small-scale fishers to take up a pearl venture. The local governing bodies have to take action to resolve issues related to leasing of open sea pearl farming parks to promote pearl culture activities. Pearl farming schemes with financial aid to fishers to initiate pearl farming have to be developed by the fisheries departments of maritime states. During the initial phase fishers/farmers have to be financially and technically guided to undertake pearl culture. In French Polynesia one of the reasons for the success of pearl industry is that small-scale co-operatives have been promoted through a cooperative organization which helps with finance, technical advice on culture aspects and marketing through loans secured from development banks.

FIG.8. PLAN FOR DEVELOPMENT OF PEARL INDUSTRY IN INDIA

TARGET



IMPLEMENTING BODY

Research and Development — **Research Institutions**

- Development of black pearl production in *Pinctada margaritifera*
- Repopulating natural pearl beds of A&N Island waters
- Selective breeding of pearl oysters to improve the quality of pearl
- Production of triploids to get implantable oysters more frequently.
- Pearl production through tissue culture.
- Feasibility of using the west coast for further nacre production during congenial months.
- Indigenous shell bead nucleus production.
- Diversification of entire pearl farming package into different economically independent modules like - mother oyster culture, surgery units, spat production units etc.

TOT programme — **Maritime states**

- Developing pearl culture as a rural development programme
- Financial aid to small scale fishers to initiate pearl farming
- Motivating small-scale fishers for adoption of pearl farming activities.
- Developing legal frame work to protect open sea/ coastal pearl farms and providing security and protection from encroachment

Market Promotion — **Export Development Agencies**

- Setting up Central marketing board for promoting pearl trade
- Opening up of trade of Indian cultured marine pearls in the international market through GJEPC*
- Developing value added products from pearl shells

** Gem and Jewel Export Promotion Council of India.*

Another pearl oyster resource of India is the black lip pearl oyster, *Pinctada margaritifera* of the Andaman and Nicobar Islands. Except for a few experiments on the seed production techniques, this resource has not been studied in detail. In the coming years, focus will be to develop technique for black pearl production in the A&N Island waters. Concerted efforts will be made to rebuild the natural population both through planting of seed produced in the hatchery and by developing natural spat collection techniques.

India is now preparing to enter the world pearl market through a well planned research and a developmental plan formulated to support the growth and production of two types of pearls, the golden pearl from *Pinctada fucata* and the black pearl from *Pinctada margaritifera*. The CMFRI is in the process of providing a focal slant to research on *P. margaritifera* and the day is not far off for India to emerge as a major player in the marine pearl industry in the international market.

Crisis in Marine Capture Sector calls for Re-orientation of Research Priorities

Prof.(Dr.) Mohan Joseph Modayil, Director, Central Marine Fisheries Research Institute, reiterated the urgency of taking steps for coastal stock management, and exploration/exploitation from the oceanic/deep sea fish stocks, coupled with the development and upgradation of mariculture technologies as alternative options to tide over the present crisis in the capture sector. In this context, he emphasised the need for a total reorientation in the marine fisheries R&D at the national level in view of the declining/stagnating yields of the exploited coastal stocks, under/unexploitated deep sea and oceanic resources and inadequate marine fisheries management and policy planning. CMFRI has been consistently addressing the above issues and contributing to the needs of the sector and government through its research, education, training, transfer of technology and consultancy programmes. Further, Regional/National Brainstorming Workshops have been conducted and researchable issues to be addressed relevant to the concerned maritime States have been identified, the Director added.

2000-2001 was a year of great significance and relevance to CMFRI in the context of the present scenario. In addition to consolidating and making further progress in the ongoing in-house and sponsored research programmes, 13 NATP funded projects with a total outlay of Rs. 702 lakhs in frontier areas were take up by CMFRI. Agricultural Technology Information Centre (ATIC) under NATP was established with the aim of ushering in single window delivery system on an enduring basis. Technology Assessment and Refinement (TAR) through Institute-Village Linkage Programme (IVLP) was initiated at Elankunnapuzha village of Vypeen Island in Kerala.

The major research accomplishments of CMFRI have been recounted by Mohan Joseph as follows:

The Institute's estimation of marine fish landings of the country during the year 2000 stood at 2.7 million t as again, says Mohan Joseph, Director, CMFRI. An estimated catchable potential yield of 3.9 million t. Kerala contributed 6.04 lakh t, of which oil sardine alone formed 2.4 lakh t. It is gratifying to know from the Director that the Institute's earlier exploratory surveys with medium range trawlers, which led to the location of substantial quantities of deep sea prawns since 1999 from the southwest coast from the outer shelf/slope, proved fruitful.

The database generated by CMFRI on exploited fish stocks has proved helpful in revalidating the potential yield of marine fisheries of the Indian EEZ for formulating management measures and evolving the comprehensive national marine fisheries policy of the country, the Director clarified.

It was pointed out that a comprehensive survey and assessment of ornamental fish resources of the Lakshadweep was conducted by the Institute and the results indicated that there was vast scope for developing a sustainable ornamental fish exploitation for strengthening the export market.

Among the other achievements, it was mentioned that the Institute had a breakthrough in achieving spontaneous spawning and larval rearing of camouflage grouper, *Epinephelus polyphekadion* in controlled conditions. Technology of breeding and seed production of highly priced marine ornamental 'clown fish' was upgraded. The induced maturation and breeding of tiger prawn by artificial insemination technology was standardised. Third generation of tiger prawn seeds was produced from domesticated broodstock, it was revcaled.

Another point mentioned was: The tissue culture programme in pearl oyster made good progress at the Institute. The demonstration project on commercial propagation of marine pearl production under the ICAR Revolving Fund made good headway. Rs. 7 lakhs were realised from the sale of pearls.

Group farming of mussels adopting CMFRI technology has been futher intensified along the coasts of Kerala and Karnataka and the annual production of cultured mussels increased from 200 to 600 t, valued at Rs 21 lakhs, The Director explained.

Studies on aquafeed biotechnology proved the beneficial effects of gut probionts in shrimp feeds. It was shown by the Institute that the pollution in aquaculture system can be minimised by keeping low P/N ratios of ingredients in the feed, Mohan Joseph mentioned.

The technologies developed by the Institute on commercial production of shrimps, mussel, edible oyster, clams, pearl oyster farming and pearl production were transferred to the fish farmers and entrepreneurs in different parts of the country and the process is continuing, according to him. The package of practices developed are also continuously upgraded/refined to suit the location-specific conditions through various outreach programmes like TAR-IVLP of the Institute, he added.

HRD Programmes: The M.F.Sc. and Ph.D. courses under education, training programmes under KVK and TTC are being continued. Proposals were submitted for accreditation of the Postgraduate Programme in Mariculture and starting courses in M.F.Sc Marine Fisheries Resources Assessment and Management and Ph.D. in Marine Biodiversity, the Director elaborated.

Consultancy: That a total revenue of Rs.51.9 lakhs was earned by the Institute through completed consultancy/contract projects during the past ten months, was another aspect mentioned.

Targets: Referring to the targets he listed the following: 1) Publishing a White Paper on status of major marine fishery resources of India, (2) Reviewing trends in major fisheries and development of predictive models (3) Black pearl production using blacklip pearl oyster in Andamans, (4) Intensification of mariculture research and development of an International Centre for Tropical Mariculture at Mandapam, (5) Establishment of Biodiversity Division, (6) Upgradation of Visakhapatnam and Veraval Research Centres into Regional Centres, and (7) Establishment of Acquisition of a National Institute status for CMFRI.

Introducing Mohan Joseph Modayil, Director, Central Marine Fisheries Research Institute, Cochin

Prof.(Dr.) Mohan Joseph Modayil, a renowned academician with commendable contributions in marine science, mariculture and community- based coastal resource management has taken charge as the Director of Central Marine Fisheries Research Institute, Cochin in September 2000. He took Masters degree in Marine Biology from Kerala University and doctorate in Bioscience from Mysore University. Dr. Modayil was the Professor and Head of the Department of Fisheries Resources Management, College of Fisheries, University of Agricultural Sciences, Mangalore where many students derived benefit from his store of knowledge. He has also served as visiting scientist in the University of North Wales (UK) and University of Science, Malaysia. He has more than 90 research reports, articles, manuals, books and reviews to his credit in national and international journals.

Prof.(Dr.) Modayil has served as consultant to various international organizations such as ODA - PHEP,British Council, DFID of the British Government, IDRC of the Canadian Government and IFRTO of the Islamic Republic of Iran. Endowed with sharp editing capabilities, the professor had served in the Editorial Board of several national and international research journals. He travelled widely, visiting more than 15 nations on professional assignments. He has taken keen interest in organizing interaction within the scientific community. Prof.(Dr.) Modayil has contributed to the growth and development of science by serving as a founder member in national level Scientific Societies like Asian Fisheries Society, (Indian Branch) of which he was the honorary secretary till recently. He is also a member of international associations like IRDC Mollusc Culture Network, Canada, Coastal Resource Research Network, Canada, and Coastal Management in Tropical Asia Network, Srilanka. He has played a major role over the past three decades in bringing together creative minds by organizing symposia, workshops and seminars. These conferences have resulted in the publication of scientific information for researchers, resource managers, industry regulators, and other decision-makers. Prof.(Dr.) Modayil is the current President of the Marine Biological Association of India.

Expertise and interest in Molluscan Mariculture took Prof.(Dr.) Modayil to the major pearl producing nations like Australia and Philippines where he interacted very actively with the pearl researchers and farmers. He was also invited to contribute a section in the Academic Press book "Tropical Mariculture" and the IDRC book 'A Mosaic of Molluscs'. With a wide vision, the Director of CMFRI, Prof.(Dr.) Mohan Joseph Modayil has identified development of black pearls from the Black-lip pearl oyster, ***Pinctada margaritifera****, a natural resource of the Andaman and Nicobar Islands, as a thrust research area for securing a place for the nation in international pearl trade.*

Book Review

Name of the Book : Statistical Techniques in Microbiology

Name of the Author and his Contact Address :

K.S. Udupa
Professor and Head,
Department of Agricultural Sciences
College of fisheries, Kankanady
Mangalore - 575 002

Often Biologists try to avoid mathematical intricasies in their subjects. However, for the growth of the subject, application of mathematical and statistical principals would be very important. In a subject like microbiology, there are a number of techniques which are based on statistical principles. These include measuring the growth of bacteria, estimation of the number of bacteria, measurement of the virulence of bacteria etc. Most often, microbiologists perform these techniques without trying to understand the statistical basis of these techniques.

In this context, the book "Statistical Techniques in Microbiology" by Prof. K.S. Udupa is a very valuable contribution. Prof. Udupa has been teaching statistics and its application in various biological sciences for nearly three decades and his rich experience in teaching both undergraduates as well as postgraduates is reflected adequately in this book.

The chapter "Data Handling in Microbiology" lays a sound foundation for the development of further topics such as growth of microorganisms, estimation of total cell counts with or without counting chambers, estimation of total counts by membrane filter techniques, estimation of viable plate counts, binomial and poisson distribution in colony counts, and statistical principles of estimation of most probable number (MPN). The chapter on measurement of virulence covers adequately the application of various methods such as Read & Meunch, Spearman-Karber method and the advantages and disadvantages of these methods. The chapter on non-parametric tests covers the application in comparison of results between different tests such as bacterial counts, antibiotic sensitivity tests etc. The book also gives the list of references for further reading and an appendix containing various tables which are essential for interpreting results of various microbiological estimations.

The book is written in a simple language that can be understood easily by students studying microbiology. This book is a very valuable contribution in the field of statistical microbiology and I would recommend this very strongly not only for students of fishery science but also for students studying general microbiology and biotechnology.

Reviewed by ***Prof (Dr.) I.Iarunasagar***

Alarming Luminous Disease in Shrimp Hatcheries

B. Trinadha Babu
Consultant Scientist-Aquaculture
HIG 1/16, Sagar Nagar
Visakhapatnam 530 043.

Y. Prabhakara Rao
Associate Professor
Department of Zoology
Andhra University
Visakhapatnam 530 003.

R. Madhavi
Professor
Department of Zoology
Andhra University
Visakhapatnam 530 003.

Increased aquaculture production is becoming increasingly essential to meet the growing demand for fish products, for the main reason that most ocean resources are now being utilized close to their sustainable limits. During the last decade, aquaculture has been the fastest growing industry in the food sector at an annual growth of over 160%. Shrimp farming has established itself into one of the largest and most valuable segments of aquaculture industry with major developments throughout South and South East Asia as well as South and Central America. However, in the middle of 1990s, industrial shrimp aquaculture encountered severe health related economic losses. In Asian countries alone, annual losses due to disease problems have been estimated to be more than US $3000 million. Another aspect is that the exponential growth of shrimp culture is not supported by a sufficient supply of healthy fry because of many complicated and interrelated problems.

Bacterial diseases have been implicated to be one of the most devastating diseases, which can completely destroy hatchery productivity for extended periods. Significant larval mortalities in Asian shrimp hatcheries, including India, are often associated with luminescent vibriosis caused by *Vibrio harveyi* or *V. splendidus*. The disease is widely known as 'Luminous disease'. Because this problem is similar throughout Asia, scientists from several countries including The Philippines, Indonesia, Malaysia, India, Thailand and Taiwan are focusing their research inputs to determine the cause, diagnosis and to develop technologies to control and prevent these luminescent bacterial infections. The present paper reviews the impact of luminous disease in shrimp hatcheries and the possible remedies for minimizing losses through its prevention and control.

Pathogenesis

Some information is available regarding the incidence and intensity of luminous bacteria in shrimp larvae. Midgut contents of broodstock shed into the water almost simultaneously with the eggs during spawning are suspected to be the main source of luminescent vibrios (Shariff and Subasinghe, 1992). In addition, the near shore seawater may also be a major source of infection (Lavilla-Pitogo *et al.*, 1990) because luminous bacteria are found abundantly in marine and estuarine habitats (Hastings and Nealson, 1981; Jiravanichpaisal et al., 1994). Some studies have indicated that *V. harveyi* has emerged into a devastating pathogen of penaeid larvae, especially those of the black tiger shrimp (Baticados *et al.*, 1990; Lavilla-Pitogo *et al.*, 1992; Karunasagar *et al.*, 1994). However, previous studies have also indicated that it is a normal constituent of the non-pathogenic flora of marine animals (O'Brien and Sizemore, 1979; Ruby and Morin, 1979). All these luminous bacteria, whether normal flora or pathogens, can exhibit bioluminescence.

Luminous disease was reported initially from *Penaeus monodon* larvae at naupliar to mysis stages (Ruangpan 1987). Songserm *et al.* (1990) also observed the incidence from nauplioid to postlarval stages of *P. monodon*. Since then, a rising incidence of luminous disease that can cause 80-100% mortality to the larval stock has occurred in hatcheries all over the Asian countries. Ruangpan *et al.* (1995) attempted to investigate the incidence of luminous bacterial species found in the diseased shrimp. The results indicated that *V. harveyi* was predominant accounting for 70% of the isolates while *V. fischeri* and other luminous species for 6.7 and 23.3% respectively. However, vibriosis causes mortality in larvae, postlarvae, juveniles, subadults and also adults. At times, outbreaks result in mortality up to nearly 100% of affected populations (Lightner, 1983). The gross signs of localized infection in the cuticle or subcuticle are called shell disease or black or brown spot disease and these superficial infections develop into systemic infections under some circumstances. Finally, it is the systemic infection that causes mortality. Any wound or rupture on the exoskeleton is a good site for luminous bacterial infection.

The disease outbreaks are reported to be initiated by sudden changes in coastal water due to monsoon rains or cyclones (Prayatno and Latchford, 1995). Species such as *V. harveyi* are universally present in coastal water and appearance of pathogenic or luminous forms is often associated with changes in salinity, temperature or nutrients, some of which can be induced experimentally (Prayatno and Latchford, 1995). Results from experimental bath infections confirmed that zoea and mysis stages are more susceptible than postlarvae. The studies also suggest that they induce the disease more frequently in dry than rainy season and it is mostly related to salinity levels or effluents from culture operations. It was found that alkalinity affects luminescence expression. Higher than the optimal pH media gives strong luminescence. Mostly *V. harveyi* has been confirmed to be a pathogenic agent associated with shrimp mortality. Experimental studies proved that an intramuscular injection of luminescent *V. harveyi* strain in combination with a bacteriophage is fatal to juvenile shrimp (Ruangpan, 1998).

Earlier studies indicated that the bacterial pathogenesis results in

mortalities up to 100% for nauplioid to zoeal stages. Living or dead shrimp larvae and even the seawater in disease outbreak areas exhibits luminescence in the dim light. Other gross features of the diseased shrimp are milky white bodies, weakness, swimming disorders and loss of appetite eventually leading to death. Using luminous media (LM) (Baumann and Baumann, 1981), luminescent bacterial colonies can be isolated from the diseased specimens as well as from hatchery rearing water. These pathogenic forms multiply in intestine and enter the hepatopancreas for further multiplication and then invade the blood and liberate toxins. Hence, the infected shrimp shows a bluish hue and emits bioluminescence. The movement of shrimps in groups looks like lights moving in the dark. This is due to the electron transport that proceeds by reaction of luciferase enzyme which catalyzes the interaction amongst reduced flavin mononucleotide ($FMNH_2$), oxygen, and a long chain aliphatic aldehyde to produce flavin mononucleotide (FMN) and also aliphatic carboxylic acid emitting the light (Fisher *et al.*, 1995). Virulence is mostly associated with extracellular products (ECPs) including proteases, haemolysins and cytotoxins (Liu *et al.*, 1996) which allow the bacteria survive and replicate within the host tissues (Ellis, 1991). The intensity of bioluminescence is directly proportional to the luminescent Vibrio bacterial density. There are some chronic carriers, which cannot be eliminated from the larval cultures. When they die or eaten by others, a sudden multiplication of the bacteria occurs causing luminescence and this happens particularly when the shrimp larva experiences any stress due to physicochemical or environmental conditions.

Stressors

Over the last few years, a number of shrimp hatcheries have begun to sound the alarm concerning luminescent vibriosis. This has resulted in severe larval and postlarval stress in *P. monodon*. Bacterial septicemia that has resulted either directly or indirectly from relatively long-term stress is one of the reasons for shrimp mortality (Lightner, 1993). The environment decides the crucial balance between the host and pathogen. In many a situation, the shrimp under culture live healthy normal life even in the presence of pathogens but when environmental stressors occur and the balance tips in favour of the disease. Any imbalance in the microbial flora of rearing water or in the gastrointestinal tracts of shrimp may lead to pathogenesis (Rengpipat, 1996). Shrimp larvae undergo stress due to factors such as inadequate physicochemical and microbiological quality of culture water, inferior nutritional status and high stocking densities. To control luminous vibriosis and other diseases, it is important to follow the appropriate management techniques that improve sanitation or reduce culture stressors. Proper sanitation, cleaning and drying of culture tanks are essential every time before use to reduce pathogenic infections. Rigorous water management methods must be adopted to prevent the entry of luminescent vibrios through culture water. To achieve this, chlorination, UV sterilization and ozonization are used in culture systems but it is an expensive approach. Partial sterilization of culture water can cause pathogen numbers recording higher than normal population level resulting in specific pathogen becoming more prevalent. It appears that sterilization of culture water results in the selective development of pathogen communities that could differ from the natural population of bacteria causing a collapse in the larval culture. In recent years, an interesting development has taken place with the use of filtered seawater. A filter of 3μm pore size allows only the normal bacterial communities to remain and use of this has resulted in better survival and growth rates of cultured shrimp larvae. However, in most of these areas, further research is needed to optimize system characteristics and to develop localized application depending on the prevailing environmental conditions.

Antibiotic treatment holds to control this infectious disease only if the underlying stress is removed. Controlling infectious disease with therapeutic measures includes injections, feed additives and use of chemicals for dip, flush, bath and indefinite treatments. Therapeutic measures should be used only as a last resort and routine use of chemicals should not be encouraged because disease causing organisms may develop resistance. Alternative drugs or a combination of drugs can also be recommended basing on the sensitivity tests. Moreover, when treating a culture species, the maximum recommended dosage has to be used rather than a series of sublethal doses. However, use of excessive antibiotics has also been implicated causing biological damage to the rearing larvae ranging from growth retardation, abnormal morphogenesis, stress induction, and decreased antioxidant defences. Vibrios rapidly become resistant to the antibacterial drugs that are typically used to manage bacterial loading of rearing tanks making their use ineffective. The reason for great concern is that antibiotics have revolutionized the control of infectious diseases. Baticados *et al.* (1990), Ruangpan and Kitao (1992), Karunasagar *et al.* (1994), Ruangpan *et al.* (1997) and Trinadha Babu *et al.* (2000) stressed on the indiscriminate use of antibiotics as a control measure against luminous vibriosis, which has resulted in drug resistant bacteria. The chlorination would not result in elimination of vibrios present in the sediments completely and therefore repopulation of the pathogen occurs immediately after dechlorination in the culture systems. Presterilization of larval culture water is not always effective as opportunistic pathogens rapidly recolonize cultures (Baticados and Pitago, 1990; Alabi *et al.*, 1997). Interestingly, Karunasagar *et al.* (1996) have shown that *V. harveyi* can form biofilm on various surfaces such as plastic, cement, stainless steel etc. and such biofilm cells are resistant to treatment of antibiotics and chlorine even at 100ppm level. The biofilms formed by the bacteria are reported to be protected by antibacterial agents making the treatments ineffective (Costerton *et al.*, 1987) and these biofilms cause anoxic conditions, producing hydrogen sulphide

and ammonia, which again are detrimental to growing shrimp larvae. Such biofilm bacteria resistant to antibiotics and antimicrobial agents may be a cause for the present virulence problems in shrimp hatcheries (Trinadha Babu *et al.*, 2000). Thus it is evident that it is not possible to eliminate luminescent vibrios by use of sanitizers and chemicals. After harvesting, treatment of the larval rearing facilities with a flush or vigorous spray of freshwater has been recommended as a routine practice. "All in-all out" batch culture punctuated by thorough disinfection and drying has to be adopted as a general practice to manage the pathogens.

Avoidance of stress is one of the most important ways to prevent disease. The culture species should be well fed, not over-crowded and not handled excessively. Good water quality must be maintained. An easy way to avoid stress is to stock the culture species in low numbers and to use small amounts of feed. Although luminous pathogens exist naturally in the water, they certainly need carbon and nitrogen (C+N) for the growth and multiplication. Thus, the first action to be taken to reduce the pathogen is not to overfeed the shrimp as the leftover nutrients in the tanks will be helpful for the multiplication of pathogenic bacteria. To prevent environmental stress to the animals, it would be important to degrade the toxic substances (waste products). Microorganisms are highly versatile and can utilize toxic substances such as ammonia and hydrogen sulphide and convert them to less harmful nitrate and sulphate.

The concept of cleaning the environment using microorganisms is known for quite some time. The term 'bioremediation' is often used to describe the process of converting the environmental parameters to favourable levels using microorganisms. These microorganisms which are actually probiotics (selected strains of *Bacillus* spp.) can eliminate pathogens by competitive exclusion and could become important tools in disease management in shrimp larviculture. Probiotic bacteria secrete many enzymes that degrade slime and biofilms of vibrios. The enzymes break down not only the slime layers around gram-negative bacteria but also utilize the organic matter and make the nutrients unavailable to the growing vibrios.

More recently researchers have sought beneficial microbes for shrimp aquaculture by attempting to isolate them from seawater, sediments and gastrointestinal (GI) tracts of marine animals. These are capable of producing antibiotics and/or antimicrobial substances that can inhibit the growth of pathogens. Austin and Day (1990) have already reported beneficial bacteria and unicellular algae capable of inhibiting pathogenic bacteria. Garriques and Arevalo (1995) suggested that the use of *Vibrio alginolyticus* as a probiotic could significantly increase growth and survival of *Penaeus vannamei* post larvae by the competitive exclusion of potentially pathogenic bacteria. Rengpipat *et al.* (1998) isolated Bacillus strain S11 from the GI tract of *Penaeus monodon* broodstock. This strain inhibited the luminescent disease bacterium *V. harveyi* and could promote better survivals of black tiger shrimp larvae. Bioaugmentation and the use of probiotics are significant management tools but their efficiency depends on understanding the nature of competition between the species or strains of bacteria.

The application of microbial biotechnology, although not simple, is indeed feasible and necessary in shrimp larviculture. Interestingly Robson *et al.* (1997) reported that luminescent bacterium utilizes an N-acyl-homoserine lactone (AHL) signaling system to activate the transportation to swarming phase which produces luminescence, exoprotease and/or virulence. Since a small number of genes are involved, it may be possible to block the AHL pathway by using AHL mimics which will bind to the bacterial AHL receptors and prevent inter-bacterial signaling that results to inhibit the expression of virulence. It has been shown that the marine alga *Delisea pulchra* inhibits fouling by the production of furannoses which interfere with AHL mediated expression of bioluminescence, swarming, motility and exoenzyme synthesis in different bacterial species (Kjelleberg *et al.*, 1997). However, Misciattelli *et al.* (1998) suggested that both the production of AHL analogues or mimics are widespread amongst the marine algae and they prevent swarming and virulence in *V. harveyi*. It is possible that these compounds may be used to control bacterial populations by incorporating in microencapsulated diets (MED) for penaeid larval cultures. The potential biotechnological application of this approach to the control of virulent luminescent bacteria in shrimp culture systems is far reaching. Unlike antibiotics and bactericides, which kill bacteria leading to the selection for resistance in any survivors, the suppression of a behavioural trait such as swarming and virulence may not induce resistance selection as bacterial numbers are not affected. In addition, no new compounds would be introduced into marine ecosystems since the present AHL mimics are derived from marine algae. Before bacterial-swarming behaviour can be initiated, the AHL concentration in the medium must rise sufficiently for communication to occur between bacteria (Robson *et al.* 1997). An alternative approach to the control of virulence would be to ensure dilution of either the medium or bacterial numbers so that this critical AHL concentration is never attained. This may explain why presterilization of culture water is seldom successful, since rapid bacterial repopulation usually follows (Alabi *et al.*, 1997). Hence, the microbial manipulation procedure appears effective and economical, and demonstrates a clear need for further research into identifying potential strains of microorganisms and evaluating their importance under field conditions.

Defence system

Nevertheless, for successful larviculture practice, the cultured animals (larvae) should have the strength of tolerance to some extent for infection. At present, the most important strategy to protect shrimp larvae against luminescent vibriosis appears to be by enhancing

their natural defence system. Harnessing the host's specific and non-specific defence mechanisms for controlling diseases has considerable potential for health management in shrimp larviculture. This will help to reduce stress from handling and environmental manipulation in order to control disease expression under intensive culture conditions. Frequent health control measures will permit the detection of shrimp immunodeficiencies. This will in turn assist to develop the strategies to decrease the disease susceptibility. Important biotechnological interventions are being developed in the field of immunostimulants and modulators in an effort to reduce shrimp's susceptibility to disease. Immunostimulants and non-specific immunoenhancers are being incorporated into diet to provide added protection to the animals, even though our knowledge of shrimp immunity is limited at present. Glucans, the cell wall components of many fungi and yeast, are routinely incorporated in vaccines and feeds and have been reported to show an impact on shrimp immunization. Sung *et al.* (1994 & 1996) suggested that ß-glucan treatment enhances disease resistance in tiger shrimp larvae. The disease resistance following immunostimulation with Vibrio bacterium and yeast ß-1,3 glucan has been found to be short lived (Karunasagar and Karunasagar, 1999). Further they reported that it is essential to repeat the treatment to sustain the resistance. The effectiveness of many of these immunostimulants and vaccines has yet to be established. Preliminary results from biological trials appear highly variable. In addition, the fluctuation and genetic diversity reported in luminous vibrios might cause difficulty in generating shrimp vaccines directed to a particular strain (Suwanto *et al.*, 1998). Further research and field trials are clearly essential to determine the precise mechanisms of the action of these immunoenhancers and to evaluate their efficacy in commercial shrimp larval production.

Conclusions

Integrated control of luminous vibrios in shrimp hatcheries requires more information on their number, diversity, distribution, association with shrimp disease, population in nearshore water, larva-rearing water and root of infection. Diseases will continue to occur and intervention will remain necessary at all levels of culture operations. The changing stressors imposed by intensive larval culture will alter disease profiles and priorities, which will in turn affect the disease prevention requirements. All disease management efforts must be coordinated to ensure that disease is not a significant limiting factor to growing shrimp culture industry.

Many new methods in this respect have been and continue to be developed but their implementation at the culture level has in most cases been frustratingly slow. Transferring the benefits of new innovations in shrimp health management and disease control with practical techniques for use in a commercial form is one of the biggest challenges facing shrimp aquaculturists. For many reasons, the implementation of current knowledge lags far behind the capability available.

Considering the importance of shrimp aquaculture and its limitations due to disease problems, the lack of specialists in the field of pathology, immunology and genetics of penaeids, particularly in the producing countries is surprising. The crisis situation can be explained by the fact that the industry developed rapidly with very little scientific knowledge to support the new culture techniques. The training for local scientists in specialized areas of shrimp physiology is thus of prime importance. These training programmes have to be organized periodically by the concerned Aquaculture Authority of respective countries and these are of utmost importance for sustainable growth of the industry.

References

ALABI, A. O., YUDIATI, E., JONES, D. A. and LATCHFORD, J. W. 1997. Bacterial levels in penaeid larval culture. In: Flegel, T. W. and MacRae, I. H. (eds.), Diseases in Asian Aquaculture, Fish Health Section, Asian Fisheries Society, Manila.

AUSTIN, B. and DAY, J. G. 1990. Inhibition of prawn pathogenic *Vibrio* spp. by a commercial spray-dried preparation of *Tetraselmis suecica*. *Aquaculture*, **90**: 389-392.

BATICADOS, M. C. L. and PITOGO, C. L. 1990. Chlorination of seawater used for shrimp culture. Isreali *J. Aquaculture-Bamidgen*, **42**(4): 128-130.

BATICADOS, M. C. L., LAVILLA-PITOGO, C. R., CRUZ-LACIERDA E R., de la PENA L. D., and SUNAZ, N. A. 1990. Studies on the chemical control of luminous bacteria *Vibrio harveyi* and *Vibrio splendidus* isolated from diseased *Penaeus monodon* larvae and rearing water. *Dis. Aquat. Org.*, **9**: 133-139.

BAUMANN, P. and BAUMANN, I. 1981. Marine genera *Photobacterium, Bencekea, Alteromonas, Pseudomonas, Alcaligenes*. In: Mortmer, P. S. *et al.* (eds.), The prokaryotes. Vol. II, Springer-Verlag, New York, pp. 1302-1331.

COSTERTON, J. W., CHENG, K. J., GEESEY, T. L., LADD, J. C., NICKEL, M., DASGUPTA, M. and MARRIE, T. J. 1987. Bacterial biofilms in nature and disease. *Ann. Rev. Microbiol.*, 41: 435-464.

ELLIS, A. E. 1991. An appraisal of the extracellular toxins of *Aeromonas salmonicida*. *J. Fish Dis.*, 14:265-277.

FISHER, A. J., RAUSHEL, F. M., BALDWIN, T. O. and RAYMENT, I. 1995. Three-dimensional structure of bacterial luciferase from *Vibrio harveyi* at 2.4A° resolution. *Biochemistry*, 34: 6581-6586.

GARRIGUES, D. and AREVALO, G. 1995. An evolution of the production and use of a live bacterial isolate to manipulate the microbial flora in the commercial production of *Penaeus vannamei* postlarvae in Ecuador. In: Browdy, C. L. and Hopkins, J. S. (eds.), Swimming through Troubled Waters, Proc. of the special session on shrimp

farming, Aquaculture '95, World Aquaculture Annual Meeting, San Diego, California, 2-6 February 1995, pp. 53-59.

HASTINGS, J. W. and NEALSON, K. 1981. The symbiotic luminous bacteria. In: M. Starr, H. Trueper, A. Balows, and H. Schlegel (eds.), The Prokaryotes. A Handbook on Habitats, Isolation and Identification of Bacteria, Springer-Verlag KG, Berlin, pp. 1322-1345.

JIRAVANICHPAISAL, P., MIYAZAKI, T. and LIMSUWAN, C. 1994. Histipathology, biochemistry and pathogenicity of *Vibrio harveyi* infecting black tiger prawn *Penaeus monodon*. *J. Aquat. Anim. Hlth.*, **6**: 27-35.

KARUNASAGAR, I. and KARUNASAGAR, I. 1999. Diagnosis, treatment and prevention of microbial diseases of fish and shellfish. *Curr. Sci.*, **76**: 387-399.

KARUNASAGAR, I., OTTA, S. K. and KARUNASAGAR, I. 1996. Biofilm formation by *Vibrio harveyi* on surfaces. *Aquaculture*, **140**: 241-245.

KARUNASAGAR, I., PAI, R., MALATHI, G. R. and KARUNASAGAR, I. 1994. Mass mortality of *Penaeus monodon* larvae due to antibiotic resistant *Vibrio harveyi* infection. *Aquaculture*, **128**: 203-209.

KJELLEBERG, S., STEINBERG, P., GIVSKOV, M. M., GRAM, I, MANEFIELD, M. and De NYS, R. 1997. Do marine natural products interfere with prokaryotic AHL regulatory systems. *Aquat. Microb. Ecol.*, **13**(1): 85-93.

Lavilla-Pitogo, C. R., ALBRIGHT, L. J., PANER, M. G. and SUNAZ, N. A. 1992. Studies on the sources of luminiscent *Vibrio harveyi* in *Penaeus monodon* hatcheries. In: Shariff, I. M., Subhasinghe, R. P. and Arthur, J. R. (eds.), Diseases in Asian Aquaculture I, Fish Health Section, Asian Fisheries Society, Manila, The Phillippines, pp. 157-164.

Lavilla-Pitogo, C. R., Baticados, M. C. L., CRUZ-LACIERDA E R., and de la PENA L. D. 1990. Occurrence of luminous bacterial disease of *Penaeus monodon* larvae in the Philippines. *Aquaculture*, 91: 1-13.

LIGHTNER, D. V. 1983. Disease of cultured penaeid shrimp. In: Mc Vey, J. (ed.), Handbook of Mariculture, Vol. I. Crustacean aquaculture, CRC Press Inc., Boca Raton, FL., pp. 289-320.

LIGHTNER, D. V. 1993. Diseases of penaeid shrimps, In: Mc Vey, J. P. (ed.), CRC handbook of Mariculture, 2nd ed. Vol I, Crustacean Aquaculture, CRC Press, Boca Raton, FL., pp. 393-486.

LIU, P. C., LEE, K. K. and CHEN, S. N. 1996. Pathogenicity of different isolates of *Vibrio harveyi* in tiger prawn, *Penaeus monodon*. *Lett. Appl. Microbiol.*, **22**: 413-416.

MISCIATTELLI, N., JONES, D. A., SIMOES, N., LATCHFORD, J. W. and BRIDSON, P. 1998. Manipulation of bacterial populations in shrimp larval cultures fed artificial diets. In: Flegel, T. W. (ed.), Advances in Shrimp Biotechnology, National Center for Genetic Engineering and Biotechnology, Bangkok, pp. 109-115.

O' BRIEN, T. H. and SIZEMORE, R. K. 1979. Distribution of luminous bacterium *Beneckea harveyi* in a semitropical environment. *Appl. Environ. Microbiol.*, **38**: 928-933.

PRAYATNO, S. B. and LATCHFORD, J. W. 1995. Experimental infections of crustaceans with luminous bacteria related to *Photobacterium* and *Vibrio*: Effect of salinity and pH on infectiosity. *Aquaculture* **132**: 105-112.

RENGPIPAT, S. (1996). Microbes and black tiger shrimp culture. *Thai J. Aquat. Sci.*, **3**: 42-51.

RENGPIPAT, S., RUKPRATANPORN, S., PIYATIRATITIVORAKUL, S. and MENASVETA, T. 1998. Probiotics in Aquaculture: A case study of probiotics for larvae of the black tiger shrimp (*Penaeus monodon*), In: Flegel, T. W. (ed.), Advances in Shrimp Biotechnology, National Center for Genetic Engineering and Biotechnology, Bangkok, pp. 177-181.

ROBSON, N. D. A., COX, R. J., McGOWAN, S. J., BOYCROFT, B. W. and SALMOND, G. P. C. 1997. Bacterial N-acyl-homoserine-lactone-dependent signaling and its potential biotechnological application. *TIBTECH*, **15**: 458-464.

RUANGPAN, L. 1987. Diseases of cultured marine shrimp in Thailand: *Penaeus monodon* and *P. merguinesis*. In: Limsuwan, C *et al.* (eds.), Technical Paper for the First Seminar on Marine Shrimp Culture, Fisheries Science Club, Kasetsart University, Bangkok, pp. 46-62.

RUANGPAN, L. 1998. Luminous bacteria associated with shrimp mortality. In: Flegel, T. W. (ed.), Advances in Shrimp Biotechnology, National Center for Genetic Engineering and Biotechnology, Bangkok, pp. 205-211.

RUANGPAN, L. and KITAO, T. 1992. Minimal inhibitory concentrations of 19 chemotherapeutants against Vibrio bacteria of shrimp *Penaeus monodon*. In: Shariff, M. *et al.* (eds.) Diseases in Asian Aquaculture I, Fish Health Section, Asian Fisheries Society, Manila, pp. 135-142.

RUANGPAN, L., TABKAEW. R., YOSHIDA, T., KAWATSU, H. and SAITANU, K. 1995. Numerical taxonomy of *Vibrio* spp. isolated from black tiger shrimp, *Penaeus monodon*, cultured in Thailand. In: Shariff, M. *et al.* (eds.), Fish Health Section, Asian Fisheries Society, Manila, pp. 131-140.

RUANGPAN, L., SODTHONGKONG, C., and SRIKAEW, Y. 1997. Luminous bacteria in shrimp aquaculture area of Songkhla. Proc. of DOF Seminar. Bangkok, pp. 65-74.

RUBY, E. G. and MORIN, J. G. 1979. Luminous enteric bacteria of marine fishes: A study of their distribution, density and dispersion. *Appl. Environ. Microbiol.* **38**: 406-411.

Shariff M and Subasinghe R. P. 1992. Major diseases of culture shrimp in Asia: An overview. In: Fulks, W. and K. L. Main. Diseases of Cultured Penaeid Shrimp in Asia and The United States, The Oceanic Institute, Honolulu, Hawaii.

SONGSERM, M., SUKSRINGAM, B and SRISOPAPORN, P. 1990. Study on the bacterial luminescent disease in jumbo tiger shrimp (*Penaeus monodon*). *Srinakarin-tarawiroj Res. Develop. J.*, **4**(1): 15-24.

SUNG, H. H., KOU, G. H. and SONG, Y. L. 1994. Vibriosis resistant induced by glucan treatment of tiger shrimp *(Penaeus monodon). Fish Pathol.*, **29**: 11-17.

SUNG, H. H., YANS, Y. I. and SONG, Y. L. J. 1996. Enhancement of microbicidal activity in the tiger shrimp *Penaeus monodon* via immunostimulations. *J. Crust. Biol.*, **16**: 278-284.

SUWANTO, A., YUHANA, M., HERAWATY, E. and ANGKA, S. L. 1998. Genetic diversity of luminous Vibrio isolated from shrimp larvae. In: Flegel, T. W. (ed.), Advances in Shrimp Biotechnology, National Center for Genetic Engineering and Biotechnology, Bangkok, pp. 217-224.

TRINADHA BABU, B., PRABHAKARA RAO, Y. and MADHAVI, R. 2000. Virulent Vibrio problems in shrimp aquaculture, *Fishing Chimes*, **20** (8): 49-52.

First Seafood Irradiation Centre to come up soon

The country's first seafood irradiation centre is expected to be set up either at Bhubaneshwar in Orissa or at Visakhapatnam in Andhra Pradesh in the state sector.

The venue of food irradiation centre is expected to be finalised by the two chief secretaries of the respective states shortly.

Food irradiation process is mainly used to extend the shelf-life of seafoods among others, thereby reducing the post-harvest losses of these products.

The proposed irradiation project is expected to have a capacity to annually process around 10,000 tonnes, which will result in an irradiation of two tonnes of seafood products per hour at 6,000 hours of operation per year in three shifts.

The setting up of irradiation centres would be a step towards substituting the fumigation process in tune with the WTO norms for food trade, it is stated.

SUSTAINABLE INDIAN FISHERIES

Editor: T.J. PANDIAN

Publisher: National Academy of Agricultural Sciences, New Delhi
Year: 2001, Pages 327, Size: 21.5 x 27.5 cm
Price: Rs. 300/-; besides Rs. 50/- for postal/delivery charges

This book is an outcome of an one-day discussion held by leading Indian fisheries experts, who have identified the components for a relevant and balanced fisheries policy for India. It points out both strong and weak facets of our fisheries and aquaculture enterprise. Each of the experts was invited to comprehensively contribute a chapter in his/her area of expertise. The MSs were subjected to peer-review; the revised MSs were presented and discussed. Hence the book represents a comprehensive account of those invited contributions.

The book includes 16 topics classified under sections: Capture Fisheries, Aquaculture, Post-Harvest and Education and Publication in Fisheries. It commences with an introductory (N.B. Nair) and thought-provoking (M. Sakthivel) chapters. Capture fisheries includes titles on coastal (E. Vivekanandan), freshwater (V.V. Sugunan & M. Sinha) and deep-sea fishing (S. Somvanshi). The Aquaculture section includes status reports on freshwater (S. Ayyappan & J.K. Jena) and brackishwater (G.R.M. Rao & P. Ravichandran) aquaculture of India. Chapters on feed production (T.J. Pandian *et al.*), diseases of shrimp (I. Karunasagar & I. Karunasagar) and diversification of aquaculture (M.N. Kutty) will be of immense help to aquaculturists. Contributions on the need for conservation of germplasm resources (A.G. Ponniah) and legal framework (M. Sakthivel) are also included. The Post-harvest section comprises chapters on transport and handling of fish (K.K. Balachandran *et al.*), fish processing (B.A. Shamasundar) and fish for nutritional security (Ghafoorunissa). Titles on education and publication are contributed by S.A.H. Abidi and S. Arunachalam and their colleagues, respectively. It also includes a special strategic chapter on "A Prelude for Fisheries Policy of India".

Prof. M.S. Swaminathan, Dr. R.S. Paroda and Prof. V.L. Chopra have given Foreword for the book and recommended that "the book will be useful for post-graduate students, research scholars, scientists, policy makers, entrepreneurs, aquaculturists and fish farmers".

The book is sold on non-profit basis. Educational institutions, scientists and students receive 15 % discount. For ordering 10 copies one complimentary copy will be free, over and above the 15 % discount.

Your orders may be sent to the undersigned by Money Order or DD drawn in favour of "Editorial Secretary" payable at Madurai.

E-mail: ***tjpandi@pronet.net.in***
Fax: 0452-859134
Phone: 0452-858212

Dr. T.J. Pandian
National Professor
School of Biological Sciences
Madurai Kamaraj University


BMR
THE AQUA PEOPLE
SPIRULINA FLAKES
BLACK TIGER
Artemia Cysts
POND
HUFA
ENRICH
SALT CREEK
REVOLUTION
1
2
3
4
... a commitment to quality

Oxyflow

BOOSTS

Sustained Oxygen Flow For Healthy Aqua Farms

OXYFLOW boosts D O level at your farm,

for

- Better health.
- Weight gain.
- Reduced mortality and
- FLOW OF MORE MONEY FROM YOUR FARM.

OXYFLOW is beneficial for all conditions of oxygen deficiency in aqua ponds such as:

- lack of sunlight
- cloudy weather
- rainy season
- extreme hot climate
- over-crowding in ponds
- OXYFLOW keeps pond bottom clean by reducing noxious gases like H_2S, NH_3, etc.

Advantages

* Flooding the body of shrimps/fish with oxygen from OXYFLOW boosts oxygen flow in the pond, forces the rapid elimination of harmful gases, therby enhancing growth of better harvest, repairs damaged tissues and improves liveability.
* OXYFLOW - maintains activity - at all levels of hardness of water.
* Oxidising power of OXYFLOW limits the growth of anaerobic bacteria and reduces harmful effects of toxins, keeps the pond fresh for growth and improves harvest.
* OXYFLOW releases oxygen even in the presence of organic matter like culture excreta waste and lack of photosynthetic activity.

Available in Pack of 1 kg

Usage Suggestion: (Water 2ft depth) : 250 - 350 gm/acre; 500 gm/acre in extreme cases

GUYBRO CHEMICAL, C-58, Piknik Apartments, Versova, Andheri (W), Mumbai-400 061.
e-mail: guybro@guybro.com Web: www.guybro.com

Aquaculture Development Possibility on Hills through Integrated Watershed Management

V.R.Suresh
ICAR Ressearch Complex for
N.E.H. Region,Manipur Centre
Lamphelpat, Imphal
Manipur - 795 004

B.K.Mandal
ICAR Research Complex for N.E.H.
Region,
Umiam - 793 103
Meghalaya - 793 103

Watershed areas consist mainly of mountain ranges, hills and uplands. These cover about 20% of the surface of earth. In India, areas with mountainous soil account for 7% (23 mill. ha.) of the total geographical area. More than 9% of our population directly depend on these upland resources. These hilly areas are also abode of great fish biodiversity and about 3.3% of our fish resouroes live in upland waters. However, the ever increasing demand for fish and their indiscriminate capture in the past has caused considerable damage to the natural upland fishery resources. While the fishery sector of the plains in India has achieved considerable progress in fish production technology, the development of fishery in hill regions remained by and large stagnant. This is mainly because the fishery of upland areas are predominantly capture-oriented in streams, rivers and lakes with highly limited potential, coupled with the difficult terrain, poor socio-economic condition of the people and several other biotic and abiotic factors. This trend has to be reversed through suitable development programmes, designed specifically for hilly areas to expand the upland fishery resources by bringing more area and species under sustainable aquaculture practice. Integrating aquaculture with watershed development programmes can bring enormous opportunities for the growth of upland fishery sector, helping the mountain communities with additional means for better livelyhood.

Concept

Watershed management (WSM) as defined in India is : 'Rational utilization of land and water resources for optimum and sustained production, with minimum hazard to natural resources' (Singh and Katoch, 2000). Essentially, this is soil and water conservation on the hills. There could be fish, where there is water. Fish use water as a substrate and do not deplete it. Small and large water bodies already existing or created, in watersheds could be profitably utilized for fish production. The enormous amount of rainfall received on the hills can be harvested in the form of direct rainfall, surface and subsurface runs-off into harvesting ponds through soil and water conservation measures and can be viably utilized for fish farming. This is not normally possible on unmanaged hills as the rain water runs off quickly, often causing erosion, landslide and down stream flooding. Many other vocations viz., agriculture, horticulture, animal husbandry, poultry etc. can also be effectively integrated with Aquaculture and to generate additional resource, employment and income, without damaging the environment.

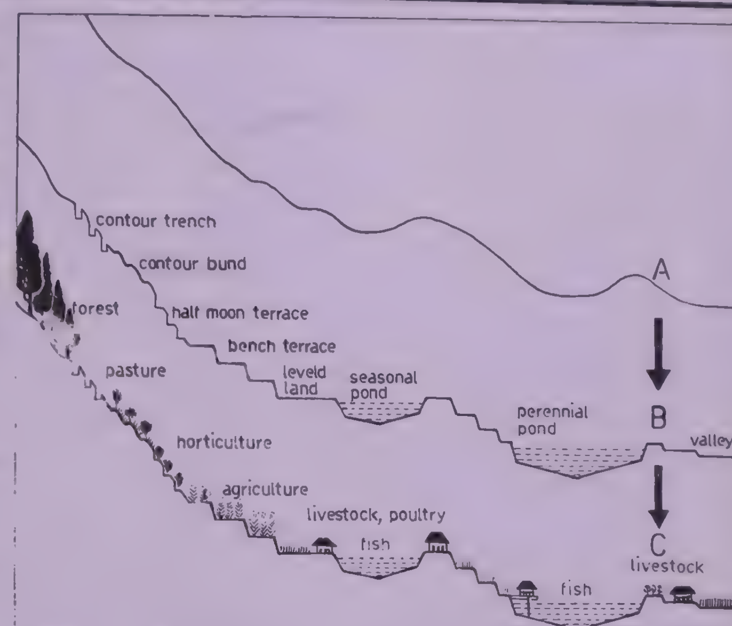


Fig 1. An unmanaged watershed (A), after soil and water conservation measures (B) and integrating with plants, livestock, poultry and fish (c).

Table 1. Cost of land development on different soil and water conservation works (Slope 30-55%).

Soil and Water conservation measures	*Mandays reqd. per ha.*	*Remarks/ Suitability*
Contour trenches	90	Fodder grass
Contour bunds	135	Agriculture Horticulture Fodder grass
Bench terraces	400	Agriculture Horticulture Fruitculture
Half moon terraces	150	Horticulture Fodder/Mixed
Grassed waterways	50	Agriculture Fodder grass

Compiled from Prasad et al. (1987).

Water harvesting

At a minimum level, 10 to 20% of the rainfall can be harvested as run-off into one hectare pond from every 10 ha area of a watershed (Sastry *et al.* 1997). The principle for water conservation in wa-

Table 2. Fish species suitable for farming in water harvesting ponds.

Regions	*Name*
Cold water	
a. Trouts	: *Salma trutta fario*
	Salmo gairdneri gairdneri
	Schizothorax richardsoni
	Schizothorax cumaonensis
	Schizothorax esocinus
b. Mahseer	: *Tor putitora*
	Tor tor
	Tor khudree
	Tor mosal
	Acrossocheilus hexagonolepis
c. Others	: *Barilius bendelisis*
	Labeo dero
	Labeo dyocheilus
	Garra gotyla
	Glyptothorax pectenopterus
	Nemacheilus spp.
	Puntius sarana
Warm water	
a. Major carps	: *Catla catla*
	Labeo rohita
	Labeo bata
	Cirrhina mrigala
	Ctenopharyngdon idella
	Hypophthalmichthys molitrix
	Cyprinus carpio
	Aristicthys nobilis
b. Cat fishes	: *Clarias batrachus*
	Heteropneustes fossilis
c. Air breathing forms	: *Channa marulius*
	Channa striatus
Warm water sp. promoted to cold water	: *Catla catla, Labeo rohita, Cirrhinus mrigala, Cyprinus carpio, Clarias batrachus.*

Fig 2. Integrated watershed at ICAR Research Complex for NEH Region, Umiam, Meghalaya. CT. Contour trenches, CB. Contour bunds. HM. Half moon terraces, BT. Bench terraces, W. Water ways, L. Livestock, P. Fishery pond.

tersheds is to facilitate infiltration of water into the soil by providing sufficient 'resident time' for rain water on the hill slopes. This would improve the soil profile and in turn enrich the ground water table in the foot hill and valley lands. Various land management measures for this, presently under recommendation are :

(a) **Contour trenching**: This consists of excavating trenches, continuous or staggered, of 30 cm deep and 45 cm wide along the contour at a vertical interval of 1 to 1.5 m. Good for long slopes.

(b) **contour bunding**: These are created by excavating parabolic channels of 0.2m deep and 0.3m wide on the top, along the contours and spreading the dugout soil in the form of a bund at the lower margin of the channel. This can be at a vertical interval of 1 to 1.5m. and good for medium slopes.

(c) **Half moon terraces:** These are level circular beds having 1 to 1.5 m diameter, cut in half moon shape, on the slopes having 20-30% gradient.

(d) **Bench terraces**: On slopes with 8 to 15% gradient, levelled terraces may be made along the contour by cutting and levelling. A mild slope should be provided for the terraces towards the hill side, for rain water to collect toward the hill. Vertical distance between two terraces should not be more than one m.

(e) **Land levelling**: A 1% slope reduces the run-off to 5 to 6% of the rain fall than a 5% slope which results in 50% run-off. Hence the slopy land levelled to 1 to 2% is ideal.

(f) **Grassed waterways**: These are narrow, open channels, laid out preferably through natural drainage lines, acting as outlets for the excess water from trenches, bunds, or terraces. These can be protected by planting local grass and lead to the water harvesting ponds. The grass protects the channel from erosion and prevent siltation in the pond.

(g) **Water harvesting ponds**: These can be dugout or embankment type on suitable areas where water can be collected on gravity flow on the foot hills or valley. This may be perennial or seasonal, depending on the water collection capacity of the watershed. The seepage and evaporation loss of water from the ponds, to a greater extent, is compensated by the water percolating down into the pond from the hill slopes.

Figure 1 (A and B) shows the graphic depiction of the transformation of the unmanaged hill slope for water harvesting through land management. Experimental ponds at the foot hill of a watershed at Meghalaya received 2.3, 75.3 and 22.4% water as surface flow, sub-surface flow and direct rain respectively (Prasad, *et al.* 1987). Where the soil is highly porous the ponds can be clay-lined or stone pitched on sides of seepage. Low Density Polyethylene (LDPE) film lining is also effective to check seepage loss (Sharma and Gupta, 1999). Depending on the topography and slope of the watershed, all the measures mentioned above or as required, may be adopted. These measures have been proven through the watershed-based Farming System Research (FSR) programmes of the ICAR Research Complex for NEH Region, where 90-95% rain water could be harvested and soil erosion reduced to negligible level (Prasad *et al.* 1987). Nearly 90% of these measures can be created by utilizing local resources and labour. Cost of such measures involves 80% manual labour, local earth, stones and grass. Table 1 shows a general picture of the cost in terms of manpower involved in these measures for slopes between 30-55%, in the north east.

Integrated approach

Integrated farming is a practice incorporating various farming components, including plants, animals, birds and fish, by utilizing and recycling the resource and waste from one component to other, to optimise production efficiencies and achieving maximum biomass harvest from a unit area, with less of external inputs. The same approach has to be adopted in watersheds to optimise resource utilization and production. In fact, the soil and water conservation measures described earlier, by itself, open up areas for integrating other vocations like forestry, agriculture, horticulture, animal husbandry, poultry, apiculture, sericulture etc. along with aquaculture in managed watersheds, all in an interdependent self-supporting system.

The waste from different farming components viz., agriculture, livestock, polutry etc. can be utilized for fish production. Fish can easily convert organic waste to the tune of 4.5 kg into 1 kg of flesh. While the water and silt from the pond can be utilized for crops, a portion of the crop production or by-product can be used to raise livestock, poultry and as fish feed. The dung from livestock and poultry can be used as manure for crops as well as for fertilizing fish ponds. Thus a complete recycling is achieved, with less input for each of the components from outside the system.

In an integrated watershed, the upper one third area should be reserved for forests and silviculture. The middle area can be utilized for horticulture and fodder crops etc. on the contour bunds and half moon terraces. The lower one third area can be used for horticulture, agriculture etc., on bench terraces and levelled lands. Below this, livestock, poultry, duckery etc. can be set up near the water harvesting ponds utilized for fish farming (Fig.1 C and Fig.2). Various options suitable for integrated watershed for some of our agro-climatic regions have already been developed. Agri-horti-silvi-pastoral system with livestock, poultry and fishery can be the base model. However according to local conditions, suitable plant, animal and fish components can be incorporated. These components should be meticulously chosen so that most of these are mutually benefited by one another.

Fish species and culture potential

There are a number of candidate species, suitable for farming in integrated watersheds. The watershed areas in India are distributed with wide geographic and climatic variations. Depending on these, there are cold water fishes for waters having an optimum temperature range of 10-12°C, warm water forms of the plains for areas where water temperature seldom falls below 20°C and some of these can be promoted for culture in cooler waters. Table 2 shows some of these important candidate species from economic point of view. Composite farming has been found to be more productive. Farming of *Catla catla, Hypopthalmichthys molitrix, Cyprinus carpio, Acrossocheileus hexagonolepis, Tor putitora, Tor tor, Labeo dero an Labeo pungassia* in a watershed pond at an altitude of 3500 feet above MSL. showed highly encouraging results (Mandal, 1985). Composite culture of Catla, Rohu, Mrigal and common carp at a ratio of 2.5:1:1.3:2.5 with a stocking density of 8000 nos ha in LDPE film lined seasonal ponds in a watershed in Meghalaya gave a net profit of Rs.9,981/- in six months (Singh and Mandal, 1985). Thus "run-off-fed" aquaculture in water harvesting ponds of watersheds hold good promise.

Future

As "run-off-fed" aquaculture in natural or modified watersheds, with integration of other enterprises is comparatively a new venture, the vast hilly areas spread throughout the Himalayas, Eastern mountains, Aravali, Vindhya, Satpura, Western ghats and Eastern ghats as well as other small isolated hills in India offer good scope for development. The topography and hydrology of these areas favour water harvesting systems, which in turn promote agriculture, livestock, poultry and support fish farming. If watershed based fish farming through composite culture and integrated farming is promoted even in a small fraction of the area that can be developed, fish production is bound to increase many fold, bringing in associated benefits to the hill society. Fish farmng on the hills would automatically bring down the capture pressure on wild fish stocks, helping conservation of natural fish bio-diversity. Macro watersheds can be planned for an entire village with people living within it, or individual families can manage micro watersheds. In the north-east a two ha integrated watershed with annual/perennial system can be managed by an average tribal family (Prasad *et al.* 1987). Thus an integrated watershed with scientific water harvesting, crops, livestock and fish farming would ensure greater food security and environment protection.

Acknowledgement

We acknowledge all the help and support received from Dr. N.D.Verma, Direc-

tor, ICAR Research Complex for NEH Region, Umiam, Meghalaya-793 103.

References

Mandal, B.K. (1985). Fisheries. Annual report, Part-III : 25-27. ICAR Research Complex for NEH Region, Shillong, Meghalaya.

Prasad, R.N., A. Singh and Arun Varma (1987). Application of Research Findings for Management of Land and Water Resources in Eastern Himalayan Region. ICAR Research Complex for NEH Region, Shillong. Bulletin. p 50.

Sastry, G., V. Hussenappa, G.C. Bansal and K.G. Tejwani (1981). Hydrological aspects of farm ponds in Doon Valley. CSWCRTI. D. Dun, Bulletin No. 6.

Sharma, B.K. and H.S. Gupta (Ed.) (1999). Technological options for North Eastern Hill Region. Soil and water conservation : 33-34. ICAR Research Complex for NEH Region, Umiam, Meghalaya.

Singh, C.M. and K.K. Katoch (2000). Technologies for managing hill agriculture resources. *Indian Farming*, 49(11) : 57-61.

Singh, A. and B.K. Mandal (1985). Water harvesting and fish production. Farming System Research, Annual Report. Part IV. 13-16. ICAR Research Complex for NEH Region, Meghalaya.

Global Aquaculture: India occupies an uncomfortable second position

India stands occupies position in global aquaculture next to China which occupies the first position. The production gap between the two countries however is glaringly conspicuous, with China producingf 67% of the global output and India 6%.

Quoting from the Washington based World Watch Institute, INFOFISH has pointed out that with the long tradition of fish farming spanning three thousand years, China accounted for 21 million mt of the world's 31 million mt of aquaculture production, while India contributed a little over 2 million t.

With the most efficient conversion ratio from grain into protein, aquaculture has emerged as the fastest growing segment in the world food economy.

Production from aquaculture zoomed from 13 million t in 1990 to 31 million t in 1998. "With aquaculture output growing at 11 per cent a year over the past decade, fish farming is poised to overtake cattle rearing as a food source in the near future", the report said.

While cattle consume 7 kg of grains to convert it into 1 kg of live meat, every 2 kg of grain consumed by fish results in 1 kg of live meat. In effect, it offers a potential source of employment and revenue to lower income populations, the report points out.

FAO Sets up sub-committee on Aquaculture

FAO has formally set up the new sub-committee on Aquaculture, which will provide guidance for governments and international bodies on technical and policy matters.

Genetic Guidelines for Fish Hatchery Managers

Gopal Krishna and Pramod K. Pandey
Department of Fish Genetics and Biotechnology
Central Institute of Fisheries Education
Versova, Mumbai-400 061

The genetic potential of commercially important fishes has to be harnessed for maximizing the fish production output and obtaining increased economic returns. Genetic management of fish population implies that the biological production is exploited without reducing the genetic diversity and affecting the gene pool. It has been observed that in the anxiety to accomplish seed production targets, many important genetic aspects are overlooked in hatchery management. When there is breeding between the closely related individuals, many economic traits such as fecundity, uniformity of egg size, survival of spawn, survival of fry, their body conformation, vigour etc are adversely affected. To avoid the harmful effects of inbreeding and to improve the profitable traits in the fishes the following available tools should be used for improvement of fish stock : 1) Selective Breeding, 2) Hybridization, 3) Gene and Genetic manipulation, 4) Grading up, 5) Germ plasm preservation, and 6) Gene transfer and transgenic production.

Selective Breeding

Selection means allowing the best stock to breed and produce the progenies. The basic effects of selection is to change the array of gene frequencies. The effect of selection that can be observed is restricted to change the population mean. The selection is practised for the betterment of desirable traits like growth, survival rate, hardiness and disease resistance, body forms, food conversion efficiency, early or delayed maturation, meat quality etc., through exploitation of the potential of the individuals maximally. On the basis of individual performance (mass selection), performance of collateral relatives (family selection) or based on the weightage of different traits towards the economic value (selection index), we select the future parents to produce progeny with improved genetic potential. Selection of the brooders depends on many factors like age, physical conditions, morphological appearance, heritability of the trait, its correlation with other economic traits etc.

Hybridization

Hybridisation is the mating of two individuals of established species/breeds. Inter-generic and inter-specific hybrid production is a matter of great significance because the hybrids are produced to be of considerable benefit in respect of better adaptability to adverse agro-climatic conditions and disease resistance. Many hybrids of different species like catla X rohu, rohu X catla, rohu X calbasu, catla X calbasu, calbasu X catla, mrigal X catla and others have been reported in nature and also produced through hypophysation. It has also been reported that the hybrids are better than one parent in some traits and some other traits, are better than other parent. Superiority of the hybrids for different economic traits is of great critical value as well as concern. This makes the hybridization process more useful and applicable.

Gene and Genetic manipulation

Gene and genetic manipulation is a faster way to improve the genetic potential of the indigenous stock. It includes the chromosome manipulation through polyploid production (autopolyploids). Triploids and tetraploids are produced to give better economic returns. Polyploids are more robust because of extra sets of chromosomes. Androgenesis and gynogenesis which result in intense inbreeding are also used to restore a particular genotype. Gynogenesis and triploidy have been induced in many fish species like *Onchorhynchus* sp. *Carassius* sp. *Cyprinus* sp. and *Salmo gairdneri*.

Grading

Grading up of the local and nondescript population with outstanding proven stock (male/female) by natural and/or artificial fertilization can also be used as a method to improve the low yielding population.

Germplasm preservation

Preservation of gametes and embryo of outstanding and endangered species at low (0°C) and very low temperatures (-196°C) has significance because they can be used even after years for fertilization or producing progenies. Many extenders have been tried to cryopreserve the milt of salmon, exotic carps and Indian carps by different group of workers and success has been achieved in this regard.

Gene Transfer and Transgenic Production

The technology of gene manipulation and production of transgenic individuals has been developed recently in fishstock upgradation. Certain very important genes of commercial importance like Somatotroin genes, Growth hormone releasing factor genes, Metallothionein genes, Antifreeze genes, Crystalline genes, Esterase genes, Disease resistance genes and Regulatory gene sequences can be transferred to fishes for their respective values.

When the desired gene is incorporated into the main genetic make-up of the fish and is expressed in the form of gene action, the progeny of such fish has got immense importance at the breeding farms. But, there are many intricacies in the process and achievement is still a great task.

In the light of traditional methods of fish breeding and advance technology recently available, a few points which are important to avoid the adverse effects of inbreeding and production of fishes of

commercial value are listed as under :

1. To start the breeding activities at the farm, the brooders should be procured from a natural stock.
2. Male and female brooders should be procured from distantly located natural stocks.
3. The brooders should have no physical deformity.
4. Genetic characterization of the brooders should be done to make the data base of the brooders.
5. Breeding should be undertaken taking the physical compatability of the sizes of the brooders.
6. To avoid intense inbreeding, the brooders should be replaced after breeding them for three consecutive years.
7. After breeding, the broodstock (male and female) should be maintained separately.
8. The future brooders should be selected from the progeny when the stock is young based on their species characterization, sex, growth rate and physical fitness.
9. Selected brooders should be provided with optimum nutrition and managemental conditions so that the growth may be outstanding in the existing atmosphere.
10. The individuals which are close relatives should never be allowed to mate.
11. The brooders that are senile, diseased, physically defective, disabled and without family history should not be used for breeding purposes.
12. Outstanding stock of proven superior genetic worth, line breeding/ androgenesis/ gynogenesis may be maintained.
13. Gamete preservation of such superior species may also help in retrieval of high pedgreed fishes
14. To improve the quantitative traits, selective breeding should be practised.
15. Interspecific and intergeneric crosses should be followed only after exhaustion of the other methods of improvement, and
16. The hybridization practices should be adopted with a well defined objective in advance.

Obituary

N.A. Vhora leaves mortal world

Mr. N.A. Vhora, IAS, who was till recently the Commissioner of Fisheries, Gujarat State, passed away on 30th May, 2001, at Ahmedabad. Born on 20/6/1941, Mr. Vhora belonged to the Revenue Cadre of the Gujarat State and was nominated to the IAS in 1983.

During his tenure as the Commissioner of Fisheries, Gujarat State, between 12/12/1997 and 28/2/2001, Mr.Vhora took great interest in the development of the Fisheries Sector of the State, sharing the experiences of his counterparts in other states and the National Institutions concerned with the fisheries research and development.

With the co-operation of the Indian Institute of Management, Ahmedabad, he organized a national level Experience-sharing Seminar for the Fisheries Development in Gujarat, which was attended by scientists from national level Research Institutions, officials of the Union and State Governments and experts from abroad.

Soft-spoken and gentle, Mr. Vhora was popular in the official and social circles, both within and outside the State.

Fishing Chimes prays for the eternal peace of the departed soul and records its deepest condolences to the bereaved family.

Low-cost FAD 'doubles' catch

Investing in a series of fish aggregating devices (FADs) costing only around 140 US $ each has helped double the catch for a fishing community, says FAO. In the past years fishermen in the Cape Verde islands, off the west coast of Africa, watched disappointingly as large pelagic fish like tuna and mackerel passed through their area evading their gear.

Now, a FAO-coordinated project started one year ago has installed 17 FADs which are simple, inexpensive attractors suspended into the water and anchored to the sea floor. They attract valuable fish and fishermen know exactly where to drop their lines. The result has been very positive.

"A typical catch during the peak season was about 200 to 300 kg a week for a group of five boats but, in one place where the FAD was installed, the catch went up to 7000 kg," according to an FAO Master fisherman.

A FAD consists of a metal line suspended into the water, anchored by a ballast on the sea floor and held in place by a marked buoy at the surface. Swatches of net-like materials attached to the line trap the ubiquitious phytoplankton flowing by.

As the fibres become saturated with plankton, small fish feed on it and then larger fish feed on the smaller ones. Fishermen are all but guaranteed a much higher catch.

For example, cement-filled tyres become the ballast, empty gas canisters are used as the buoy and floats, and discarded grain sacks or fishing nets serve as the perfect plankton trap.

Metal swivels and other hardware are also produced locally. Final cost: about $140 for a device which descends about 80 metres into the sea.

The price of a FAD is so low, it is believed that most fishing communities can pay back the cost after no more than a month, sometimes just a week. (*Source* : FNI).

Report

National Symposium on Fish Health Management and Sustainable Aquaculture

College of Fisheries Science, G.B. Pant University of Agriculture and Technology, Pantnagar
November 1-2, 2000

From **Sunit Kumar Singh**

A two day National symposium on "Fish Health - Management and Sustainable Aquaculture" was held at the College of Fishery Science, G.B. Pant University of Agriculture & Technology, Pantnagar from Nov. 1-2, 2000. The symposium was inaugurated by Dr. J.B. Chowdhury, Vice chancellor of the University.

Dr. U.P. Singh, Dean, College of Fisheries Science, Pantnagar was the convenor of the Symposium and Dr. R.S. Chauhan, acted as Secretary of the Symposium. Dr. M.Y. Kamal, Vice Chancellor, Shere-Kashmir University of Agriculture & Technology, and Dr. S.A.H. Abidi, Member, Agriculture Scientist Recruitment Board (ASRB), New Delhi, participated in the function. Dr. K. Gopakumar, Deputy Director General (Fy.), Indian Council of Agricultural Research, New Delhi presided.

A large number of delegates consisting of policy makers, scientists, research scholars, technologists, academicians, representatives of financial institutions, government organisations, aquaculturists, industrialists, and fishermen participated in the symposium.

The developments and challenges in the various fields of fisheries science such as aquaculture, aquatic resource management, environmental impact assessment, fish parasitology, fish and shellfish nutrition, aquaculture biotechnology, integrated aquafarming & post-harvest technology were discussed at the symposium.

Dr. K. Gopakumar emphasised the need to promote a sustained increase in fish production. He said this could only be achieved by promoting sustainable aquafarming in a big way but with minimal disease risk. This was necessary particularly as fish yield from the oceans had now entered a stagnant phase. Observing that promotion of suitable culture technologies for freshwater sector was most essential, he emphasised that these developments should reflect due concern for environmental protection. He stressed on the need for greater collaborative research and urged upon the scientists working in institutes, Universities, State fisheries departments and NGOs to form into a network to avoid duplication of research. Gopakumar laid emphasis on the need for refining and adding to principles of sustainable management and approaches to risk management.

Dr. M.Y. Kamal said that development of fisheries sector of the country was confined to tropical zone for a long time. He pointed out in this context that it was high time to formulate strategies for the development of cold water fisheries sector. He emphasised the need for a deeper look into development of fisheries of the waters in the temperate zone of the country. He also mentioned that the fisheries sector was in need of trained manpower and that trained fisheries graduates and postgraduates could play a very important role by applying their technical skills and providing their services to fisheries sector. He also highlighted the need for augmented research efforts in fish pathology.

Dr. S.A.H. Abidi observed that the new millennium belonged to the third world countries and India was poised to be leader of these countries in respect of fisheries development. He also said that the health management issues both in hatchery and farms should be thought of and at each stage meticulous care should be bestowed to avoid problems. Saying that water management strategies were the key factors for achieving sustainable aquaculture, he added that health quarantine management as suggested by FAO/NACA along with other guidelines should be followed in aquaculture sector. He advised that frequent monitoring of fish health was very important as it was not easy to keep the environmental parameters within the physiologically acceptable limits of the cultured fish.

Dr. J.B. Chowdhury, Vice Chancellor of G.B. Pant University of Agriculture & Technology, delivered the inaugural address. Complimenting the Dean, College of Fisheries, Pantnagar and other faculty members for organising the symposium on a very important aspect of fisheries i.e., "Fish health management", he expressed his happiness that a large number of delegates were participating. He described the event as a memorable accomplishment. He mentioned that after the green and white revolution the blue revolution contributed substantially towards the achievement of national and household food security. He has also emphasised the need for a legal framework for aqua animal quarantine and aqua seed certification. He suggested that comprehensive aquaculture extension policy should be formulated taking into account the needs of the sector, such as research, input supplies, credit, marketing etc. The policy should also be flexible to incorporate the dynamic nature of the sector, he added.

There were twelve sessions. Scientist from Universities and research organisations like National Bureau of Fish Genetic Resources (NBFGR) Lucknow, Central Institute of Freshwater Aquaculture (CIFA) Bhubaneswar, National Research Centre on Coldwater Fisheries (NRCCWF); Bhimtal, Central Institute of Fisheries Education (CIFE) Mumbai, Central Soil and Water Conservation Research and Training Institute; Dehra dun, Central Institute of Brackishwater Aquaculture (CIBA), Chennai, Central Inland

Capture Fisheries Research Institute (CICFRI), Barrackpore, G.B. Pant University of Agriculture & Technology, Pantagar, Shere-Kashmir University of Agricultural Sciences & Technology, J & K, Indira Gandhi Agriculture University, Raipur, Punjab Agricultural University; Ludhiana, N.D. University of Agril. & Tech. Faizabad, Kumaon University, Nainital, Lucknow University, Lucknow, Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Institute of Agriculture Vishwa Bharati, Sriniketan, M.D. University; Rohtak, University of Kalyani, Allahabad University; Allahabad, Ch. C.S. University; Meerut, College of Fisheries, Berhampur, Barkatullah University; Bhopal, W.B. University of Fishery and Animal Sciences (W.B.), and Aligarh Muslim University, Aligarh took part in the symposium.

Dr. K.K. Vass, Director, National Research Centre on Coldwater Fisheries, Bhimtal, Dr. A.G. Ponniah, Director, National Bureau of Fish Genetic Resources, Lucknow, Dr. C.S. Singh, ex-Dean, College of Fishery Sciences, Pantnagar, Dr. Harpal Singh, former Dean, College of Fisheries Science, Pantnagar, Dr. K.C. Pandey, Head, Zoology Department, Lucknow, Dr. M. Sinha, Director, Central Inland Capture Fisheries Research Institute, Barackpore, Dr. V.N. Capoor, eminent Fisheries Parasitologist were among other distinguished scientists, who participated in the Symposium.

Earlier, Dr. U.P. Singh, Dean, College of Fishery Sciences, Pantnagar welcomed the dignitaries and distinguished participants.

Felicitations

Dr. K. Gopakumar, Dy. Dr. General (Fy), ICAR, New Delhi, Dr. M.Y. Kamal, Vice Chancellor, Sher-e-Kashmir University of Agriculture & Technology, J & k., Dr. S.A.H. Abidi, Member, ASRB, New Delhi, Dr. A.C. Ponniah, Director, NBFGR, Lucknow, Dr. C.S. Singh, Ex-Dean, College of Fishery Sciences, Pantnagar, Dr. V.N. Capoor, eminent fishery parasitologist, from Dept. of Zoology, Allahabad University, Dr. Harpal Singh, former Dean, College of Fisheries Science, Pantnagar, Dr. K.K. Vass, Director, NRCCWF, Bhimtal, Dr. M. Sinha, Director, CICFRI, Barackpore, Dr. K.C. Pandey, Head, Dept. of Zoology, Lucknow University, Lucknow offered felicitations.

Technical Session - I

This Session was chaired by Dr. S.A.H. Abidi, Member, ASRB, New Delhi. The co-chairman was Dr. P.K. Salena and Rapporteur, was Dr. H.S. Singh. Dr. A.C. Ponniah, Director, NBFGR, presented a technical paper titled "Issues & Strategies for Sustainable Increase in Fish Production" in which he highlighted various issues related with sustainable aquaculture covering diversified aquaculture systems, development of new strains of fish, transgenics, need for introducing quarantine system for imported aqua animals and their seed, salinisation of water tables, environmental efforts on destruction of mangroves etc. He pointed out that overfishing and destruction of mangroves might cause recruitment failure and habitat damage. He emphasised that there was urgent need to identify new candidate species for aquaculture sector for diversification of species and to bring down the loss of biodiversity. He said that pollution was one of the major causes for mortality of fishes and it reduced viablity fish fry and fingerlings.

Technical Session - II

The session was chaired by Dr. K. Gopakumar, DDE (Fy.) ICAR, New Delhi. The Co-Chairman was Dr. N.K. Yadava and Rapporteur, Dr. Hukum singh. In this session K.K. Vass, in his paper on coldwater fisheries highlighted the issues of paramount importance for the development of hill stream fishery. The issues covered aspects such as viability of aquaculture in hills, wetland management, sport fishing, water policy issues conservation of riverine resources, Involvement of NGOs in sport fishing and conservation programmes, and gear improvement for catching hill stream fishes and fishermen training. He emphasised that sport fishing programmes could promote tourism activity in hilly areas.

Technical Session - III

This session was chaired by Dr. M.Y. Kamal, Vice Chancellor, Sher-e-Kashmir University of Agricultural Sciences & Technology J & K. The co-chairman was Dr. Kamal Deep Kaur and Rapporteur Dr. M.H. Balkhi. The session started with the invited paper of A.K. Sahu. "Advances in cat fish culture - Indian Scenario". He stressed on the need to establish hatcheries for cat fish seed production. In his paper he pointed out that considering the rich biodiversity with regard to fish and shellfish species prevalent in the country, it was necessary to introduce several more species of promise with rich potentials, and consumer preference taking due care of environmental aspects. Among the existing candidate species, cat fish had got immense market potential, he said. In addition, the species being an air-breather was well adapted to adverse ecological conditions and they thrived well in derelict water bodies, he added. Altogether sixteen papers were presented in this session of Aquaculture. The important aspects on which papers were presented were a) Fishery potentials of Kumaon river systems, b) Prospects of fisheries development in Uttaranchal, c) Feasibility of Golden Mahseer Tor putitora, as a candidate species in composite fish culture of carps, d) Present status of Golden Mahseer Tor putitora in Jammu & Kashmir. e) Advances in catfish culture - Indian Scenario, f) Comparative study of fish growth in silted and desilted ponds under composite culture system in Tarai Region, g) Management of predatory aquatic insects in fish nurseries, h) Low input technology for sustainable aquaculture present status and future strategies i) Spawning performance of Rohu, Labeo rohita during different months of a breeding season in agroclimate of Tarai, j) Status of use of ovaprim/ovatide in eastern Uttar pradesh, k) Evaluation of dose and duration of ovaprim under including ovarian maturation and ovulatory response in the catfish Heteropneustes fossilis, l) Shrimp farming in India : Status, approaches and emerging trends to recoup the development m) Fishery pros-

pects of coldwater prawn of Kumaon Himalaya, Uttararhand, n) Ejjects of stocking densities on growth & survival of post larvae of fresh water prawn, Macrobrachium rosenbergii, o) Descrition of some freshwater mussels and their prospects for pearl production, and p) Socio-economic analysis of fish culture in Tarai region of Uttaranchal, etc.

Technical Session - IV

This session on Aquatic Resource management was chaired by eminent fishery parasitologist Dr. V.N. Capoor total five papers were presented in this session. The session started with the invited lecture by M. Sinha, Director, Central Inland Capture Fisheries Research Institute (CICFRI), Barrackpore. In presenting the paper titled "Management of Inland Aquatic resources - A Fisheries Perspective", he said that much had gone wrong during last few decades, worldwide in general and developing countries like India in particular, where biomass economy presently regulated the national economy. The much required sustainable fisheries development in these countries would only be a far cry in the absence of proper management of this most important natural resource. He dealt with the impact of various types of stress factors affecting the inland aquatic resources of India, and the problems and core issues of their management. The required management strategies for inland aquatic resource development in a sustainable manner had also been delineated by him.

The important aspects on which other papers were presented were

a) Ecological considerations in the management of Fisheries of Tarai Reservoirs by U.P. Singh and A.P. Sharma. The authors explained that ecological management of Tarai reservoirs required intervention in three ways i.e., 1) Changing the ecological conditions 2) Modifying the ecosystem structure and 3) Changing the species spectrum of the biota particularly fish, all bringing about a change in energy flow and nutrient circulation.

b) Management of Fisheries Resources in the upland water - An introspection by J.R. Dhanze and Rani Dhanze. The authors suggested about microwatershed development programme in slopy areas of hills for sustainable availability of water for aquaculture.

c) Degradation of lake Nainital environment and strategies for its rehabilitation by A.P. Sharma and U.P. Singh. The authors suggested two methods for conservation and rehabilitation of Nainital lake ecosystem:- 1) Aeration of the lake using appropriate technology 2) Biological management of lake through elimination of undesirable fishes using appropriate scientific methods, and selective stocking of environment friendly fish species in the lake.

A paper on Fisheries and Socio-economic status of the fishermen from Nanaksagar and Baigul Reservoirs was also presented.

Technical Session - V

The technical session on Environmental Impact Assessment was chaired by Dr. J.R. Dhanje. Five papers were presented in this session. The important aspects on which papers were presented were

a) Risk analysis of exotic magur (*Clarias gariepinus*) and Bighead (*Aristichthys nobilis*) culture in India.

b) Toxicity of neem-based pesticides to the eggs and hatchlings of Indian major carps.

c) Test hypothesis to extend investigations of fluoride effect on bones of cultured organisms.

d) Erythrocytic and leukocytic responses to lead and cadmium poisoning in a freshwater tedeost, Channa punctatus.

e) Composition of sediment and heavy metal speciation in some brackishwater ponds of sunderbans etc.

Technical Session - VI

The technical session on Fish parasitology was chaired by Dr. K.C. Pandey, Head, Dept. of Zoology, Lucknow University. The session started with an invited lecture of Dr. S.K. Malhotra, from Parasitology laboratory, Dept. of Zoology, Allahabad University, Allahabad. He delivered his lecture on "Biodiversity in Ichthyoparasitology". He pointed out that parasitic organisms with complex life cycles were the natural indicators of trophic web structure in aquatic ecosystems exhibiting deterministic pathways. Parasites often responded intrinsically to anthropogenic as well as man made pollution condition, he added.

In all, sixteen papers were presented in this technical session on various aspects of fish parasitology a) A new species of the genus *Spinitectus* separated from *Mystus tengra* of river Ganges at Allahabad, b) On a new kathlanid worm *Spectatus* spp. parasitizing freshwater food fishes from river Yamuna at Allahabad. c) Three new species of nematodes under irrigational catchment area of rivers Ganges and Yamuna and analysis of soil edaphic factors in their population dynamics, d) Dynamics of polyparasitic infection in freshwater fishes of Allahabad, e) Analysis of *Argulus* infestation in farm raised carps in sub-Himalayan region, f) Regulatory role of environmental conditions on parasitization in *Mystus tengra* and *Eutropichthys vacha*, g) Fish cestode relationship and environmental interplay in upland lotic waters h) The determinants of infection pattern and disease dynamics in freshwater fishes of a sub-humid region, i) A new cestode *Gangesia* spp. from the intestime of fish *Wallago attu* j) Aminotransferase (GOT, E.C.No.2.6.1.1, GPT, E.C. No.2.6.1.2) activity in cestode parasites harboured in fishes. k) Adhesive attitude of an ancyrocephaline monogenean *Bychowsreylla* on the gills of *Ompak bimaculatus*, l) Studies on three monogeneous parasites on *Tachysurus sona* (Mam.) from Okha, Gujrat, m) One known and two unknown species of the genus *Thaparocleidus* Jain, 1953 (Monogenea) from freshwater fishes of eastern Uttar Pradesh, India, and n) On a new cestode of the genus *Lytocestus*, Cohn 1908 from the intestine

of a freshwater fish *Clarias batrachus* from north-east Uttar Pradesh.

Technical Session - VII

This session on fish pathology was chaired by Dr. S.K. Malhotra. In all five papers were presented in this session. They were : a) Immunodiagnosis of fish diseases b) Haematological investigation on EVS affected fishes of Bhopal c) Bacteriological and Histopathological investigations on EVS affected *Puntius sarana,* d) Health management in freshwater prawn farming : an overview, and e) Prevention of infectious diseases of carps.

Technical Session - VIII

The session on Fish and shellfish nutrition was chaired by M. Sinha, Director, CICFRI, Barackpore. Altogether eight papers were presented during this session; a) Studies on utilization of some non-conventional resources in carp feed, b) Art and Science of supplementary feeding in semi intensive fish farming systems, c) Effect of Food ration on growth and survival of post larvae of *Macrobrachium rosenbergii* (De Man), d) Study of food composition in different size groups of Indian major carps in Tarai region of Uttaranchal, e) Effect of Thynoxine on the growth of Rohu (*Labeo rohita*) fry., f) Effectiveness of Cobalt Chloride and Vitamin-B complex in reducing the body burden of Cadmium in common carp, *Cyprinus carpio,* g) Effect of the Thyroxine on growth of Catla (*Catla catla*) fry, h) Balanced diet for broodstock of the Indian major carp, *Catla catla*, and induced breeding using ovatide.

Technical Session - IX

The session on Aquaculture Biotechnology was chaired by Dr. A.K. Sahu. Six papers were presented in this session. The important aspects on which papers were prsented were a) Role of Biotechnological tools in disease diagnosis in aquaculture practices, b) Fish cell culture : A scientific approach for the new millennium, c) Molecular genetic markers and their application in fisheries, d) Identification of an ulcerative disease sensitive phenotype of *Channa gachua* with the help of serum albumin polymorphism e) Aqua Pro - A herbal, growth promoter and performance enhancer for fish, shrimps, prawns and other aqua species and f) Effects of different methods on implantation of nucleus in freshwater mussels.

Technical Session - X

This session on Integrated aquafarming was chaired by Dr. K.K. Vass, Director, NRCCWF, Bhimtal. Three papers were presented in this session. The important aspects on which papers were presented were, a) An appraisal of integrated fish-livestock farming in Tarai region, b) Integrated fish farming in Saryu diara, c) On the poultry cum fish farming in Tarai region of Uttaranchal.

Technical Session - XI and Technical Session - XII

The technical session XI on Post harvest technology, and XII in respect of "Miscelleneous and Late Abstracts" were chaired by Prof. C.S. Singh, ex-dean, College of fisheries sciences, Pantnagar. Three papers were presented at technical session XI, titled a) Utilisation of Fish processing waste b) Models of dehydration of frozen food flesh and c) Image recognition for modernization of fish processing.

Seven papers were presented at Technical session XII. The important topics of the papers presented were a) Proximate composition and nutritional quality of freshwater finfish and shellfish, b) Studies on splasher type surface aerator and related aspects, c) Salinity tolerance of *Cyprinus carpio*, d) Design development and fabrication of splasher type surface aerator, e) Efficacy of Boundary-line of Dhaincha along with embankments in Paddy-fish culture field for water resource management f) Seasonal phytoplankton productivity in fish culture ponds and g) Production of fry and fingerlings of major Indian and exotic carps; A comparative techno economic analysis.

Plenary and Valedictory Session

The dignitaries present on the dais during the plenary and valedictory session were Dr. Harpal Singh, Dr. K.C. Pandey, Dr. R.S. Chauhan, Dr. U.P. Singh. The session started with the address by Dr. U.P. Singh, Dean, College of Fisheries Science, Pantnagar. Dr. R.S. Chauhan, Organising Secretary of the symposium proposed the vote of thanks.

Shrimp export prices range-bound in Andhra Pradesh

Black tiger shrimp prices continue to range around $ 13.40 - 13.60 per kg for the 16/20 counts, according to the Marine Products Export Development Authority. The average export price is, however, reported to have come down to US $ 10 per kg.

In the absence of firm orders and major purchases, the prices were expected to rule around these levels, it is felt.

Arrivals of cultured black tiger commenced in the production centres in Andhra Pradesh in April and continued till late July, with most of the produce reported to be disease-free. The fortnightly catches are believed to have increased from 600 t to over 1000 t during the period. Arrivals may continue upto August but in reduced quantities.

Whales eat 440m tonnes of fish a year

The Japanese fishery ministry says that hungry whales are a major factor behind diminishing fish returns, according to the *Japan Times*.

Japan's ministry estimates the annual global yield of fisheries at 90 million tonnes and claims that, in comparison, whales consume an estimated 440 million tonnes of marine resources. (*Source* : FNI).

Cell Culture and its use in Fisheries Science

Yogesh Kumar and Pani K.Prasad
Division of Fish Pathology
Central Institute of Fisheries Education
Seven Bungalows, Versova
Mumbai - 400 061

Viruses require living cells for replication. They cannot replicate in synthetic media. So, until middle of this century the only tools available to study viruses were animals and embryonating eggs. Subsequent developments in cell culture techniques which are less expensive and more convenient than the animals or embryonating eggs have resulted in advancement in the field of Virology, Genetics, Cell Physiology, Biotechnology and Fisheries science.

Culture of cells is usually divided into three classes: i) Primary cell culture, ii) Cell Strain, and iii) Cell line.

The source of cells for cell culture is the intact animal. The cells may be obtained from various organs and tissues of embryonic, infant or adult origin, (human, monkey, mice or fishes etc.). The cultured cells obtained directly from the animals organs and tissues are referred to as primary culture.

Primary cell culture retains some of the characteristics of the tissue from which they have been derived. With some exceptions cells in culture can be classified into two general morphological types. One is fibroblast-like cells which are thin and elongated and the other is epithelial cells which are polygonal in shape. Most of the cells produced by primary cell culture have a finite life span of five to ten divisions *in vitro*.

When a particular cell type becomes predominant after a series of transfers of primary cells, it is termed as Cell strain. These cells have a finite life span of less than hundred divisions *in vitro*.

When the cells in a cell strain undergo a transformation process (Spontaneous or induced, changed in karyotype, morphology or growth properties) they are made "immortal" (able to divide indefinitely) and are called as Cell line.

A well equipped and sophisticated microbiological or virological type laboratory is needed for preparation of cell cultures. Cell line is a developing stream of science and it is very useful not only for fisheries but also for other branches of biological sciences like Cell Biology, Virology and Biotechnology etc. This new implantation of cell line in different sciences is simple, inexpensive and it may replace the conventional studies.

Table-1: Substances used for Disaggregation of Tissues

Method	*Substance Used*	*Details*
Enzymatic	Trypsin	25 min at 37°C with stirring in serum-free medium stop reaction by addition of medium containing 20% serum.
	Collagenase	Useful for human tissues and epithelial cells.
Chelating agent with or without enzyme	EDTA	0.01 - 0.1 M
	EGTA	0.1 mM
	Citrate	40 M
Mechanical homogenization	Sieving	Limited application. Useful for desegregation of limphoid tissues & neural cells.

Procedure

Cell culture can be done from normal, embryonic and malignant tissues, the easiest being embryonic. The tissue is collected aseptically by dissection. Small animals may be disinfected by swabbing with ethanol or antibiotics. Human biopsy specimens are often collected into a medium containing double strength antibiotics, aseptically if the specimen comes from the respiratory, digestive or genito-urinary tract. The tissue to be cultured is first chopped aseptically into pieces of approximately 1 mm^3 in dimension. The simplest method of culture is to suspend the chopped material in serum-containing medium in a tissue culture flask. The pieces of tissue adhere to the substratum and cells migrate out from the cut ends.

The commonest way to initiate culture from solid tissues is to disaggregate the tissue into single cells. This can be achieved i) Mechanically, ii) Enzymatically, or iii) By the use of chelating agents.

Sometimes a combination of these methods may be used (Table 1). Once cells have been disaggregated a viable count is performed and the cells are seeded at 10^5-10^6 viable cells per cm^3. If the cells to be cultured are adherent and are placed in culture vessels that permit attachment, any cells that have not attached to the surface after 24hrs are removed by complete replacement of the medium. Embryonic cells are usually cultured at the lower density, since they usually demonstrate good plating efficiencies.

Table 2: Standard growth media and other components used for lymphoid organ culture of *Penaeus monodon* (Rao and Pani Prasad, 2000)

S.No	Component/Ingredients	Quantity
1.	Foetal bovine serum (20%)	20 ml
2.	Shrimp extract	8 ml
3.	Epidermal growth Factor (@ 100 μ g/ml)	20 μl
4.	Human recombinant interleukin-2(@ 10 μg/ml)	10 μl
5.	Penicillin/Streptomycin (@ 10,000 IU/10μg/ml)	1 ml
6.	Gentamycin	0.5 ml
7.	Salt solution	6 ml
8.	Leiovitz 15 (2xL-15 media)	64.5 ml
9.	Osmolality (mmol/kg)	475
10.	pH	7.5
11.	Incubation Temperature (°C)	28

There are two types of cells:

I. Adherent Cells are cells that need some substratum for attachment. Generally these types of cells adhere to the bottom of the flask.

eg: Mice kidney cells, Human kidney cells, mice liver cells etc.

II. Non-Adherent cells are those cells that need not require the substratum., eg., Lymphocyte cells.

Cell line can be used for a longer time by cryopreservation technique and in this technique when cell lines are maintained at reduced temperature, their metabolic rate is decreased and they require less frequent passaging. At extremely cold temperatures destructive processes as well as normal metabolic processes are inhibited and the cell lines are in a state of "suspended animation". Cell line can be stored frozen at -70°C in the presence of glycerol but over a period of month to years there is a gradual loss of viability. Storage of mammalian cells and cell lines in liquid nitrogen (-196°C) is presently the accepted procedure that results in infinitely prolonged preservation and viability.

Counting of Cells

The cell count gives a measure of the status of cells at a given time. A cell count is also essential when sub-culturing or assessing the effects of experimental treatment on the cells. The cell count can be expressed as number of cells per ml medium or per cm^2 area of attached surface (for anchorage-dependent cells).

Several different method for quantifying cells are available. These are i) Hemocytometer (Counting chamber), ii) Cell counter, iii) Flow cytometry, and iv) Biochemical methods.

Uses of Cell Lines in Fisheries Science

Cell lines can be used in Disease diagnosis, Immunological studies, Vaccine production, Genetics and Toxicological studies.

Cell Lines in Disease Diagnosis: Disease diagnosis is very important for successful fish operation. Timely, reliable and correct diagnosis of disease incidence can save fish farmers from irreparable losses resulting from disease outbreaks. Fish disease diagnosis is an integral approach incorporating results of researches on microbiology, pathology, biology and chemistry.

Generally for the diagnosis of fish diseases lengthy procedures are to be followed especially for diagnosis of viral diseases. It is necessary to collect the circumstantial data, diseased specimens and then point out the abnormal features like any spots over the body, excess amount of mucous secretion by the skin, swelling and deterioration of body parts or ulcers etc. Even before collecting the fish for real diagnosis we have to note the behaviour of the fish also. After external examination of the fish, the microbiological and histopathological studies have to be undertaken.

Basically, call lines can be used for the diagnosis of viral diseases. Virus cannot replicate in the synthetic media. It requires living cells as host. Until 1950s the only tools available to grow and to study viruses were animals and embryonated eggs. This meant many animals were to be used for a single viral study. Cell line is most convenient and widely used system for isolation and propagation of many viruses. To grow virus, established cell lines are inoculated with virus and visible signs in cells viz., cytopathic effect, transformation, syncitia formation etc., are considered as possible changes due to virus replication. The innoculated cell lines are frozen and thawed to release the virus into the medium. The medium which contains the virus is collected and is pooled and stored at -70°C, for further studies. The virus which is propagated from a diseased fish can be stored for further studies.

Cell Lines in Vaccine Production: Immunization is the process of protecting body against disease by means of manufacturing antibodies against specific antigens. There are two types of immunization, active immunization which involves the use of vaccine and passive immunization is administration of specific serum.

Active immunization is another term for vaccination, a system that contains substances that stimulate the body's im-

Table 3: Standard growth media and other components used for gills cell line (MG-3) *Cirrhinus mrigala* (Sathe *et al.*, 1995)

S.No	Component/Ingredients	Quantity
1.	Foetal bovine serum (10%)	10 ml
2.	Penicillin	400 U/ml
3.	Streptomycin	400 U/ml
4.	Gentamycin	80μg/ml
5.	Leibovitz 15 (2 x L-15 media)	90 ml
6.	pH	7.5
7.	Incubation Temperature (°C)	28

mune system to produce antibodies against a particular infectious disease. These antibodies protect the fishes from infection by that particular disease causing organism. The virus are passaged for a definite number of passages to reduce their virulence and also cell lines are utilised for mass protection. Vaccination is common in human and veterinary practice and is presently gaining importance as a tool to prophylactic measure to prevent diseases in fisheries.

The mass mortality of shrimp due to white spot disease in the coastal zones of India made the authors to think how necessary it is to develop vaccines which can protect the shrimp from the viruses. The surmise is that the best possible way is development of shrimp cell lines and subsequent preparation of vaccine using these cell lines.

Use of Cell Lines in Genetic Studies: Cell culture is specially useful in karyotyping when the survival of animal in question is a must. In such cases harvested cells from *in vitro* cell culture will provide a dependable source of cells to perform different cytological studies without harming the animal.

To produce a large number of fishes (like ornamental fishes) with identical trait/traits desirable cell culture along with cloning can be used which will help in production of synthetic trait with desirable characters.

Cell Line in Toxicological studies: In 1970, the first series of studies using spontaneously contracting primary postnatal rat myocardial cell culture for toxicological evaluations were conducted. To study drug or animal toxins including fish toxins and their toxicity, these investigators developed techniques for evaluating dose-response and time course relationships for cellular and sub-cellular injuries. Indices of toxicologic evaluation included organelle (lysosomal and mitochondrial membrane integrity, cytosolic enzyme leakage, cell viability, alternations in contractile activity and morphologic changes in shape, size and appearance).

Cell line in toxicological study has much importance because a large number of animals are required during the study of effect of toxins. Availability of mice/animals, their maintenance and availability of similar size and age are limiting factors in the study of toxins. So, to overcome these problems, cell lines are the best alternative substitute and this new method is simple, inexpensive and sensitive and can replace the conventional mouse/fish bioassay.

Conclusion

In fisheries the use of cell lines is less developed and needs more emphasis. The fish diseases, especially the viral disease outbreaks, are having a davastating effect on the fish and shellfish protection and also there is an urgent need for the development of the vaccines.

In addition to these, the cell lines offer more scope for research and development for the growth of Fisheries Science.

References

Bulter, M. and Dawson (1992) Cell Culture (LAB-FAX) Bios Scientific publishers, Academic Press.

BURLESON, F.G., CHARNBERS, T.M., WIEDBRAUK, K.L. (1992) Virology-Laboratory Manual. Academic Press. Inc.

CELIS, A., CELIS, J.E., (1994) General procedure for tissue culture, *Cell Biology*, pp. 5-9.

CHANDRIKA, V., (1993) Biotoxins in fishes, *Fishing Chimes*, 28-30.

DAVIES, B.R., RULAND, P.S., (1994) Growth and induction of metastasis of mammary epithelial cells, *Cell Biology*, 338.

DAWSON, M., (1992) Initiation and Maintenance of culture, *Cell Culture (LAB-FAX)*, 25-38.

FAISAL, M., RUTAN, J.B., SEMIDEMMERRLE, S. (1995) Development of continuous liver cell culture from the marine teleost, Spot (*Leiostomus xanthurus*, Pisces, Sciaenidae) *Aquaculture* **132**, 59-72.

KOGURE, E., TAMPLIN, M.L., SIMIDU, U., COLWELL, R.R., (1988) A Tissue culture assay for tetrodotoxin, Saxitoxin and related toxins, *Toxicon* **26**(2), 191-197.

KOU, G.H., WANG, C.H., *et al.* (1995) A cell line (EP-1 cell line) derived from "Beko disease" effected Japanese eel elver *(Anguilla japonica)* persistently infected with *Pleistophora anguillarum, Aquaculture.,* **132**:161-173.

NICHOLSON, B.L. (1988) Fish Cell Culture. An Overview : In : Invertebrate and fish culture. (eds.Kuroda, Y., Kurstak, E.&Maramorosch), K.) Japan Scientific Society Press, Tokyo, 191-196.

POLLARD, J.W., WALKER, J.M. (1989) Methods in Molecular Biology-5 Animal cell culture, 1-30.

SRONG, P.N., SMITH, J.T., KEANA, J.F.W., (1997) A convenient Bioassay for Detecting nanomolar concentration of Tetrodo toxin. *Toxicon*, **11**, 433-438.

WELDER, A.A., ACOSTA, D., (1993) Preparation of primary culture of postnatal rat Myocardial cells for Toxicological studies. Methods in Toxicology **1 A**, 147-197.

CIFT Conferred Sardar Patel ICAR Award

ICAR's Central Institute of Fisheries Technology, Kochi, 'Sardar Patel Outstanding ICAR Institution Award' for 2000 has been bagged by CIFT, Cochin. The award was presented at a function held in New Delhi on July 16. It is the only national centre where research in all disciplines relating to fishing and fish processing is undertaken. The major focus of research during 2000 had been on the development of responsible fish harvesting techniques and viable post-harvest methods.

Prosperity through Giant Freshwater Prawn Culture on the anvil in Kerala

Kuttanad area in Kerala was once a Throbbing zone for giant freshwater prawn (Scampi) culture. For various reasons, there has been a slow down in this sector, dispite the fact that Scampi commands a lucrative export market.

Thanks to relentless efforts, particularly of Dr.Madhusoodana Kurup of the School of Industrial Fisheries of the Cochin University of Science and Technology, the prawn farmers of the area are now stated to have a renewed opportunity to revive their profession.

The School of Industrial Fisheries of Cochin University of Science and Technology, has recently entered into a collaboration with Aquaculture and Fisheries Science Institute of Cantho University, Vietnam, to improve prawn culture both in India as well as in Vietnam through promotion of Scampi Seed Production.

The coming together of the two Universities is a great boon to Scampi farmers of India for the reason that this collaboration ensures the transfer of the latest technology as practised in Vietnam.

It has to be mentioned here that Vietnam had learnt the technology of Scampi culture from Malaysia in early 1990s. It has deputed two experts from Aquaculture and Fisheries Science Institute of Cantho University to work at the School of Industrial Fisheries of the Cochin University of Science and Technology (Cusat) for conducting a brief training programme on hatchery and grow-out technologies of scampi at various levels. Assistance for the training programme is provided under a project approved by the Netherlands University Foundation for International Co-operation (Nuffic).

This project holds the promise of revival of giant freshwater prawn (Scampi) in Kuttanad from where it had gradually vanished in the early 1970s due to depletion of the stock as a result of various man-made changes in the ecosystem. CUSAT had sought Vietnamese technical help taking into account a high survival rate of 50% of scampi seeds under laboratory conditions in that country compared to 20% in India. Dr.B. Madhusoodana Kurup, Co-ordinator (training) and principal investigator, Nuffic programme in India is now actively engaged in the work of bringing about the revival of the species through production of its seed and using the same for culture.

Dr. Kurup and Mr. Tran Ngoc Hai (one of the Vietnamese fishery experts in Cochin to impart the training programme), said Kuttanad was identical in climatic conditions to the Mekong delta of Vietnam where scampi cultivation was being taken up extensively. Scampi had received wide acceptance as the most suitable species among fresh water prawns in most of the South-East Asian countries due to its wide consumer acceptance, Dr Kurup said.

Dr G. Santhana Krishnan, Joint Director (Aquaculture) of the Marine products Export Development Authority (MPEDA) said that, though the country had made a rapid progress in the production and export of freshwater prawns, its vast potential in this sector still remained unexplored.

India, which was producing hardly 200 tonnes of scampi (*Macrobrachium roserbergii*) till 1996, had exported 16,000 tonnes of this species last year, as against 7,000 tonnes in 1999-2000, registering a 130 per cent growth in terms of quantity compared to the previous year. Thailand's scampi production was a record 1,00,000 t last year, he added.

While India is endowed with an estimated 5.4 million hectares of fresh water resources, only 12,000 ha out of this are utilised for freshwater prawn culture, Dr. Santhana Krishan said. Other estimates, however, put the area under scampi culture at around 50,000 ha.

MPEDA, he said, was extending technical and financial assistance up to 25 per cent of the capital subject to a maximum of Rs.30,000 per ha of water area with a ceiling of Rs. 1.5 lakh per beneficiary for the development of scampi farms. It was providing subsidy upto Rs five lakh for establishing scampi hatcheries of 30 million seed capacity and above.

In Kerala, the Kuttanad region alone has 55,000 hectares suitable for scampi culture both as part of integrated farming with paddy and also as a mono crop besides another 30,000 hectares of kole land (agricultural lands subject to flooding) in Thrissur district. There is scope for harvesting three scampi crops in a span of two years, he said.

Besides extending training facilities in scampi cultivation, the CUSAT has also developed a highly economical and protein-rich prawn feed costing hardly Rs.13 per kg against commercial feeds costing Rs.30 per kg. The CUSAT feed is now being widely used in Kuttanad area, Dr Kurup said.

Dr Kurup is confident that the Kuttanand farmers, distressed by the low returns from paddy for long, would diversify into scampi cultivation in right earnest very soon.

Korea on alert to stop Chinese fishing in its EEZ

It is reported that Korea is taking firm steps to halt the intrusions by Chinese vessels into its EEZ.

A new fisheries agreement is stated to have become effective from June 30, 2001 between the two nations, cutting down by almost 75 per cent the number of Chinese vessels allowed in Korea's waters. (*Source* : FNI).

Use and effects of Chemicals and other Biological Agents in Aquaculture Management Practices

A. Venkateswara Rao
Manager, Technical Services
Aquaculture Division, Neospark Drugs and Chemicals Private Limited
Corporate Centre, 241, B.L. Bagh, Panjagutta, Hyderabad- 500 082

Aquaculturists throughout the world have used a wide array of chemicals and biological agents in an attempt to improve soil and water quality and so as to thereby prevent or control different diseases. Some of these substances are believed to kill the disease-causing agents or its potential carriers. It is claimed that other substances stimulate the immune system of animals under aquaculture and help them resist the disease. Substances that improve environmental conditions in ponds and thereby reduce stress also are thought to enhance the resistance of animals under aquaculture to disease.

The purpose of this review is to list the major chemicals and other substances used in aquaculture and comment on their food and environmental safety status and on the risks associated with handling them. The following groups of substances are included: fertilizers, liming materials, oxidizing agents, antibiotics, plant extracts, coagulants, osmoregulators, algicides, herbicides, piscicides, water quality enhancers, probiotics and immunostimulants. The most common substances used in pond aquaculture are fertilizers and liming materials. Fertilizers are highly soluble and release nutrients that can cause eutrophication of pond waters. Some liming materials are caustic and can be hazardous to workers if proper precautions are not exercised. Liming materials do not cause environmental problems. Further, liming and inorganic fertilizer compounds do not present food safety concerns. These compounds and also biological products quickly degrade or precipitate. They are not bioaccumulative and do not cause environmental perturbations in natural waters receiving aquaculture effluents. It may be mentioned here that most substances used in aquaculture to improve soil or water quality present little or no risk to food safety. On the other hand, the use of human wastes in aquaculture or the contamination of aquaculture systems with agricultural or industrial pollution could result in product contamination and food safety concerns.

Fertilizers

Fertilizers are applied to aquaculture ponds to increase plant nutrient concentrations, stimulate phytoplankton growth and to ultimately enhance production of fish or crustaceans. The most common inorganic fertilizers are nitrogen and phosphorus compounds, but potassium, trace metals and silicate may be contained in some of the fertilizers. Fertilizers may be applied as individual compounds or they may be blended to provide a mixed fertilizer containing two or more compounds. Organic fertilizers or manures are animal wastes or agricultural by-products which, when applied to ponds, may serve as direct sources of food for invertebrate fish food organisms and fish or they may decompose slowly to release inorganic nutrients that stimulate phytoplankton growth. Primary chemical compounds used as fertilizers are highly water-soluble salts of nitrogen, phosphorus and potassium. They are usually applied in quantities necessary to increase concentrations of nitrate, ammonia, phosphate, potassium and silicate in pond waters. In addition to the primary nutrients, fertilizers usually contain a small percentage by weight of fillers and conditioners such as agricultural limestone, sand, rice hulls, granite dust or kaolin clay. Micronutrient elements are sometimes applied to ponds in much smaller quantities to supplement natural deficiencies. Because most micronutrients are not highly soluble, they are usually chelated. Fertilizer nutrients are absorbed by plants through this route enter the food web of aquaculture ponds. More than 25% of the nutrients added to ponds in fertilizers are seldom recovered in aquatic animals at harvest. These nutrients occur as constituents of biomass such as protein, calcium, phosphorous in bones and minerals. None of the chemical fertilizers are known to be of any hazard for food safety. The fraction of the fertilizer nutrients not harvested in aquaculture products can be found in other pond organisms, dead organic mater and sediment or lost in outflowing water. Nitrate can be converted to nitrogen gas by denitrification, and ammonia may be lost to the air by diffusion.

Fertilizers increase nutrient concentrations in the water. For this reason they can cause nutrient enrichment when pond effluents are released into water bodies. An interval of a few days between fertilizer application and water discharge to the surrounding environment would lead to the absorption of most fertilizer nutrients by the pond organisms, and also by sediments. Some quantity would also be lost to the atmosphere through denitrification of ammonia volatilization. Ponds are extremely efficient in assimilating nutrients if the average hydraulic residence time is several weeks. Pond bottoms are not infinite sinks for nutrients, but by periodically draining and drying pond bottoms, their capacity to assimilate nutrients can be extended. Nitrogen fertilizers have the potential to increase ammonia concentrations in the water and excessive use can result in toxic ammonia concentrations within ponds. Ammonium fertilizers and urea are acidic in pond waters because nitrification releases hydrogen ions. Nitrate fertilizers are basic because of bicarbonate produced when denitrification occurs. Ma-

nures have much lower concentrations of nutrients than inorganic fertilizers. Because of their low nutrient content, manure application rates usually are much higher than those for chemical fertilizers. Decomposition of manures by bacteria requires oxygen and the amount of manure that can safely be added to a pond depends upon the biochemical oxygen demand of the manure. Adding manures to a pond increases the potential for low oxygen concentrations in pond water and pond effluents. Manures can sometimes be contaminated by heavy metals and present some risk for food safety. In some parts of the world aquaculturists use human wastes as fertilizers, which increases the risk for contamination of aquatic animals with potential human pathogens. When possible, it is preferable to use inorganic fertilizers than manures in aquaculture ponds. Manures can be more safely and efficiently used as organic fertilizers and soil conditioners for terrestrial agriculture.

Liming materials

Liming materials are applied to pond waters and soils to neutralize acidity and increase total alkalinity. Increased alkalinity buffers water against drastic daily changes in pH common in eutrophic ponds. Increasing the pH of an acidic bottom sediment enhances the availability of phosphorus added in fertilizers. Some calcium and magnesium (Dolomite) from liming materials are absorbed by the pond biota to become normal constituents of plants and animals, adsorbed by the soil or dissolved in the water. The anionic component is either neutralized by hydrogen ions or it reacts with carbon dioxide to form bicarbonate that remains in the water to increase alkalinity. The pond sediments in coastal environments are often acidic and the liming of pond bottoms is done to neutralize acidity and stimulate microbial decomposition of the organic matter accumulated during the crop period. Burnt lime and hydrated lime are strong caustic materials and they should be handled cautiously. Contact with eyes can possible cause blinding and severe irritations can result from skin contact. If used excessively, these compounds increase water pH upto 10 or more and cause toxicity in aquatic plants and animals. The water pH will decrease to acceptable levels within a few days after applications of burnt or hydrated lime and at this stage ponds can be stocked. Agricultural limestone or dolomite is safer to use and considered to be the most effective liming material for ponds under normal circumstances. However, in ponds where severe disease problems were encountered in the previous crop, applications of burnt or hydrated lime to empty pond bottoms may be effective in destroying disease organisms in the soil before stocking for the next crop. None of the liming materials are known to be of any hazard for food safety.

Oxidizing agents

Oxidizing agents are used for controlling phytoplankton, killing organisms that cause disease or for oxidizing bottom soils. Potassium permanganate has been claimed to oxidize organic and inorganic substances and kill bacteria, thereby reducing the rate of oxygen consumption by chemical and biological processes. Some fish diseases are also treated by the application of potassium permanganate to fish in holding tanks or in ponds. In water, permanganate quickly oxidizes labile organic matter and other reduced substances and is transformed to relatively non-toxic manganese dioxide, which precipitates out. Potassium permanganate being toxic to phytoplankton will have the effect of reducing the production of dissolved oxygen by photosynthesis.

Peroxides and chlorine compounds

Peroxides and chlorine compounds are powerful oxidizing agents and they are strong irritants when highly concentrated. Calcium hypochlorite is sometimes applied to ponds to oxidize organic matter and reduce the biological oxygen demand. Treatments of pond water with large doses of chlorine may be an effective means of destroying disease-causing organisms. Sodium, potassium and calcium nitrate are sometimes used as oxidizing agents. Nitrate compounds have a basic reaction when they are used by bacteria to support anaerobic decomposition (denitrification). Oxidants are transformed to inactive forms when they react with organic matter.

The most common chlorine compounds for disinfection are chlorine gas (C_l2), calcium hypochlorite [$Ca(OCl)_2$] and sodium hypochlorite (NaOCl). When chlorine gas is added to water, it hydrolyzes to form hypochlorous acid (HOCl) and hydrochloric acid (HCl): $Cl_2 + H_2O = HOCl + H^+ + Cl^-$

Hydrochloric acid is completely ionized and depending upon pH and temperature, hypochlorous acid ionizes to hydrogen ion (H^+) and hypochlorite.

Ion (OCL):

$$HOCL = H^+ + OCL^-$$

When pH is above 2, there will be essentially no C_l2 in water. The ionization of HOCl reaches 50% at pH 7.4 and at higher pH values there will be more OCl^- than HOCl. When sodium or calcium hypochlorite is added to water they also form HOCl and OCl^- in relationship to pH and temperature. Hypochlorous acid and hypochlorite are called free chlorine residuals. The relative distribution of these two species is very important because the disinfecting efficiency of HOCl is 40 to 80 times to that of OCl^-. Chlorine readily oxidizes substances such as Fe^{2+}, Mn^{2+}, H_2S and organic matter and is reduced to nontoxic chloride ion. Once oxidation is complete, chlorine reacts with ammonia to form chloramines. After ammonia and other reduced substances have reacted with chlorine, continued addition of chlorine will result in a direct increase in free chlorine residuals (HOCl and OCl^-). The amount of chlorine that must be added to reach a desired level of free chlorine residual is called the chlorine demand.

Chlorination is a commonly used method for destruction of pathogenic and other harmful organisms in drinking water. In disinfection, enough chlorine is added to meet the chlorine demand and provide free chlorine residuals. Some organic constituents of water react with

chlorine residuals to form toxic compounds such as trihalomethanes, dioxins and polychlorinated biphenyls (PCBs). These compounds are suspected as carcinogens and they may contaminate food. Dioxins and PCBs are thermally stable molecules that resist oxidation and hydrolysis and persist in the environment. Both dioxin and PCB molecules rarely cause acute toxicity in humans, but they have marked effects after repetitive or chronic exposures. The major threat associated with their presence in shrimp is the increasing concerns in international markets over contaminated food. The implementation of more stringent regulations for food importation will ultimately lead to the rejection of shrimp containing dioxins or PCBs. Of course, there is no evidence to prove that the main source of contamination for dioxins and PCBs in cultured shrimp is the result of the use of chlorine in hatcheries or production ponds, but is traced to the use of fish oil in the preparation of feed.

Chloramine and chlorine dioxide (Clo_2) possibly have advantages over chlorine gas and calcium hypochlorite for use in water containing ammonia and organic matter in appreciable concentrations. Chloramines contain chlorine and ammonia in various proportions (NH_2Cl, $NHCl_2$, NCl_3). The advantage of chloramines is that they are already combined with ammonia and will not form halogenated organic compounds. Its disinfecting power is as good as that of chlorine, provided there is longer contact time. Chlorine dioxide is equal to or greater than chlorine in disinfecting power. It has an extremely high oxidation potential, which accounts for its potent germicidal powers. Chlorine dioxide residuals and end products are believed to degrade quicker than chlorine residuals. Formation of halogenated organic compounds has not been observed with the use of chlorine dioxide, as has been the case with chlorine and hypochlorites. There is no evidence that any of these compounds other than chlorine compounds leave harmful residues in the water or accumulate in the tissues of aquatic organisms. Thus, no food hazard is associated with them. Although chlorine compounds have been reported to form residual compounds that are suspected carcinogens, they have a long history of safe and beneficial use in the disinfection of drinking water. Therefore, the use of chlorine compounds in aquaculture does not pose a significant food safety risk, but there is some possibility of environmental contamination by reaction products of chlorine in effluents.

Formaldehyde solution (or formalin) is a general disinfectant used as a germicide, fungicide or preservative in various industries. Its main mode of action is to form covalent cross-links with functional groups on proteins. Formalin will cause irritation of the respiratory system and skin reactions in humans. It is suspected to be a carcinogen. In the context of aquaculture, while the chemical may be applied to the entire pond volume, more commonly, treatment is generally limited to puddles of water in the bottom of ponds after harvest. It is also used as a disinfectant in hatcheries. Formaldehyde is thought to be degraded by natural processes before shrimp are stocked for the next crop. No food safety hazard is known to be associated with the use of formaldehyde solution.

The germicidal effect of iodine is based on its concentration. It is commonly used to disinfect nauplii and larvae in hatcheries and farms. Iodine is thought to be degraded by natural processes in water and should not pose a threat to the environment.

Quaternary ammonium compounds (BKC) are used in hatcheries and farms to disinfect larvae, tanks and other equipment. These compounds are sometimes added to ponds at 400g/ha in attempts to kill bacteria. Quaternary ammonium compounds disrupt cell membranes and are most active against gram-negative bacteria. There is no evidence on the possibility that these compounds, their reaction products or their degradation products are bioaccmulative or pose any threat to the environment.

Antibiotics

Furazolidone is a common antibacterial specific used by humans as a prophylactic treatment. In aquaculture, it is used to disinfect larvae and as a prophylactic agent during transport. Other antibiotics are also used for the treatment of fish and shrimp diseases in hatcheries and grow-out ponds or applied prophylactically to prevent outbreaks of disease. The use of antibiotics in shrimp culture raises several issues of concern to human health, product quality and the environment. Several studies on salmon farms have shown that antibiotic residues can be extremely persistent in marine sediments and may lead to the development of bacterial antibiotic resistance. Use of chloramphenical has been seen to cause increased bacterial resistance in shrimp hatcheries. The ecological implications of such antibiotic misuse are not known, but at the very least there is a direct threat to shrimp farming created by the emergence of antibiotic resistant pathogens. There is also concern that transfer of such resistance to human pathogens could have serious human health implications. Antibiotics can leave residues in shrimp flesh that may lead to rejection of products in export markets. Residues of the antibiotic oxytetracycline were detected in farm-reared shrimp from Thailand and India and caused rejection of shipment to Japan.

Dyes

Malachite green is sometimes used in hatcheries to disinfect larvae and nauplii and also in grow-out farms. Malachite green is an organic arylmethane dye which contains no copper. Specifically, it is a diamino-triphenylmethane ($C_{23}H_5N_2$) and used extensively as a fungicide and ectoparasiticide in the aquaculture industry throughout much of the world.

Plant extracts

The plant extracts like KILOL, garlic, extract of passion fruit and neem are used in aquaculture as disinfectants. KILOL is made from extracts of grapefruit seed and contains a mixture of ascorbic acid

and large amounts of amino trace elements. It is applied to aquaculture ponds, either directly or mixed with lime and is claimed to be a general water quality enhancer and bactericide. It is also added sometimes to fish/shrimp feed. Both major compounds of KILOL are considered generally safe if added to human food. Garlic and extract of passion fruits are also applied to ponds as potential bactericides. These compounds should not cause environmental harm or pose worker safety or food contamination concerns. Natural insecticides derived from products of the neem tree (*Azadirachta indica*) are also used occasionally. They are active against nematodes, fungi and ostracods.

Coagulants

Coagulants are applied to pond waters to flocculate suspended clay particles and cause them to precipitate in order to clear the water of turbidity. Calcium sulphate (gypsum) dissolves in water to increase calcium and sulphate concentrations. Calcium and sulphate may be absorbed in small amount by plants and animals to become normal biological constituents. Aluminium and ferric iron ions from aluminium sulphate and ferric chloride applications quickly precipitate as aluminium and iron oxides. Never-the-less, these two compounds have a strongly acidic reaction in water because of the hydrolysis of iron and aluminium. Because of their high potential to create acidity, they should be stored indoors and risks of spills minimized. Aluminium sulphate and ferric chloride both should be handled with care because skin irritation can result from contact. None of these coagulants are bioaccumulative and should not be of any hazard to food safety.

Osmoregulators

These substances are applied to water to increase the salinity or the calcium concentration and improve conditions for osmoregulation by certain culture species. They are simple salts that dissolve in the water and have little influence on the composition of aquatic animal products. The two most common osmoregulators are sodium chloride and calcium sulphate.

Algicides and herbicides

Algicides and herbicides are applied to ponds to reduce the abundance of undesirable aquatic plants. Excessive phytoplankton may result in chronically low dissolved oxygen concentrations during the night and blue-green algae are responsible for off-flavour in fish and crustaceans. Larger aquatic plants create dense communities that interfere with feeding and harvest. A number of herbicides are used to control weeds in aquatic ecosystems, but only a few of them have been cleared for use in aquaculture ponds. Because of their expense and lack of effectiveness relative to mechanical and biological control techniques, their use is seldom justified in aquaculture. A variety of algicides has been used in ponds, but four of them, i.e., copper sulphate, chelated copper compounds, simazine and potassium ricinoleate, have been employed most extensively. Copper inhibits both respiration and photosynthesis in algae. High doses of copper sulphate may be acutely toxic to fish but copper compounds quickly precipitate from water as copper oxide and toxicity can be avoided if the dose does not exceed one hundredth of the total alkalinity concentration of the water to be treated. Organisms may absorb some copper, but concentrations in tissues are no greater than those normally found in native plants and fish. Decapod crustaceans also have the ability to regulate essential trace elements, such as copper and zinc, at least to some degree. No food hazard is associated with use of copper sulphate. Copper is often chelated with citric acid or triethanol amine to increase its solubility and residual time in water. These organic compounds are degraded fairly by bacteria in ponds and they do not accumulate in plants and animals.

Simazine (2-chloro 4,6 bis ethylamino-S-triazine) is a powerful photosynthesis inhibitor and is extremely toxic to phytoplankton but non-toxic to fish at the treatment rates used for algal control. Bacteria degrade simazine, its half-life is about 2 weeks and it is not known to be bioaccumulative. Potassium ricinoleate is a saponified fatty acid. It is degraded by bacteria and is not bioaccumulative. Some times dyes are used in aquaculture to shade the pond bottom and limit light for underwater weeds. These are food dyes that have a half-life of a month or more. They are not bioaccumulative or directly toxic to plants and animals. In summary, copper sulphate, chelated copper compounds and simazine are very effective algicides. They may cause problems in ponds with low dissolved oxygen concentrations immediately after treatment, but they have not been reported to cause ecological problems in receiving waters. None of these algicides are known to be bioaccumulative and should not be of any hazard to food safety.

Piscicides

The most common piscicides are tea seed cake(saponin), derris root powder (rotenone), mahua oilcake, lime, potassium permanganate and ammonium fertilizer. The teaseed cake contains 5.2-7.2% saponin, a glucoside that causes haemolysis in organisms. The higher sensitivity of finfish than crustaceans to the glucoside has made it an effective piscicide in shrimp ponds. The concentrations of these compounds used for eradicating fish vary widely. The entire pond volume is sometimes treated, but usually treatment is limited to puddles of water that remain in the bottom of ponds after harvest. These compounds are degraded through natural processes before the fish and shrimp are stocked for the next crop. No food safety hazards are thought to be associated with piscicides.

Water quality enhancers

The group of chemicals called water quality enhancers comprises products used in attempts to remove ammonia and improve water quality in ponds. The most commonly used are zeolite, KILOL and probiotics. Zeolite is an aluminosilicate clay of high cation exchange capacity and is applied to aquaculture ponds. Farmers apply zeolite with the aim to reduce ammonia concentration through ion ex-

change, providing physical cover over sediments to prevent leaching of metabolites into the water column, removing suspended solids and improving water colour and algal blooms. These functions are believed to be achieved by either flocculation of suspended solids, ionic exchange and absorption of ammonium ions by zeolite or the prevention of toxic metabolites leaching from pond sediments by covering the sediments with a layer of zeolite. Zeolite will settle to the pond bottom and it does not cause food safety problems or environmental threats.

Probiotics

The common probiotics used in pond management are live bacterial inocula (non-pathogenic organisms) and fermentation products rich in extracellular enzymes. Claims about the potential benefits of probiotics in aquaculture ponds include: enhanced decomposition of organic matter; reduction in nitrogen and phosphorus concentrations; better algal growth; greater availability of dissolved oxygen; reduction in blue-green algae; control of ammonia, nitrite and hydrogen sulphide; lower incidence of disease and greater survival and better fish and shrimp production. The addition of probiotics to aquaculture ponds should not result in any damage to the fish and shrimp crop or to the environment. No food safety hazards are attributed to application of probiotics.

Immunostimulants

The immunostimulants are used to boost the fish or crustacean immune system. They include extracts of *Phyllanthus niruri*, *Yucca schidigera* (Sarsaponin), vitamin mixes, products containing glucan, probiotics, extracts of other natural products and homeopathic products. These products are mixed with the feed. In general, immunostimulants should not cause any hazard to the environment or food safety problems.

Summary

Most chemicals used in aquaculture management pose little or no food safety risk. However, some farmers who may apply insecticides and antibiotics to ponds have to know that these substances can be bioaccumulative and present a food safety hazard. Accidental contamination of aquaculture products by pesticides and heavy metals does not appear to be a major risk. Although aquaculture chemicals are generally not a food hazard, some of the compounds pose risks to workers who apply them to ponds. Enrichment of water in aquaculture ponds is desirable, but the direct discharge of such waters may not always be environmentally sound. Management practices that will reduce potential problems from aquaculture effluents should be promoted and implemented on a larger scale. The adoption of best management practices by aquaculturists is a practical way to approach environmental management of aquaculture. Most substances used to improve water quality or to stimulate the immune system of fish or crustaceans present little or no risk to the environment or food safety. Aquaculture farmers who use these substances should follow product labels regarding dosage, withdrawal period, proper use, storage, disposal and other constraints including environmental and human safety precautions. Also, records should be maintained carefully regarding use of chemicals in ponds, as suggested by the Hazard Analysis and Critical Control Point (HACCP) method. A greater effort must be there to prepare lists of acceptable chemicals and recommendations for the use of these chemicals. Some chemicals are necessary in aquaculture and a system for using them in a safe and publicly acceptable manner must be implemented by the aquaculture industry worldwide.

Conclusion

In future, as natural fish stocks are getting depleted, it is likely that we will have to rely increasingly on aquaculture for the production of fish and crustaceans for human consumption. Therefore, it is important that the sustainability of this industry is maintained and it is essential that this be done with the minimum of impact on the aquatic environment, following improved aquaculture practices.

Major increase in Indian Giant Freshwater prawn output foreseen

India is seen to be emerging as a significant supplier of giant freshwater prawn for the global market.

Since 1992, production of the giant freshwater prawn has registered a 10-fold growth, according to the Marine Products Export Development Authority (MPEDA). Andhra Pradesh is stated to have come up as the leading producer, followed by West Bengal, Orissa, Gujarat and Kerala. Andhra Pradesh alone is stated to be accounting for over 67 per cent of the area under giant freshwater prawn aquaculture and over 85 per cent of the production.

The species is farmed in over 60 countries extending across Asia, Africa, Europe, Oceania, South, North and Central America. Alongwith the growth in farming, the species has also acquired a definite consumer preference and demand in the international markets.

Around 93 per cent of global supplies of farmed freshwater giant prawn, are computed as coming from Asian Countries. Among these countries, India and Bangladesh are reckoned as fast coming up.

The latest trend in India is to integrate giant freshwater farming with agriculture and animal husbandry. An advantage in farming this prawn is that it is resistant to disease infestation.

Both fish farmers and shrimp farmers of India who were looking for an alternative viable export oriented candidate species in India, have increasingly adopted giant freshwater prawn farming and securing profitable returns, MPEDA said.

Phenomenal development of giant freshwater prawn farming has occured in Andhra Pradesh during the year 2000. It is estimated that an additional area of 50,000 ha has been brought under giant freshwater prawn farming during the year.

In Nellore district of Andhra Pradesh, culture of giant freshwater prawn has become a major techno-economic option for farmers with extremely rapid expansion in more than 50,000 hectares of newly constructed farm ponds.

Seminar on

Sustainable Shrimp & Freshwater Prawn Culture in Orissa

Hotel Quality Inn Crown, Bhubaneswar; 29 May 2001

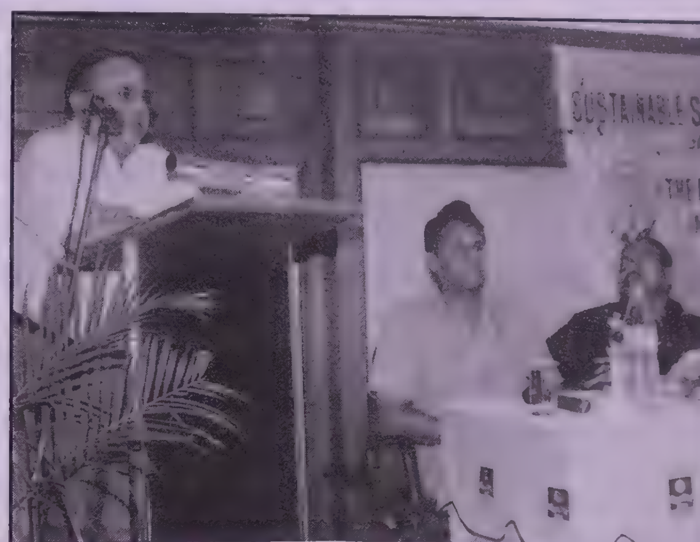
***From* H.S. Badapanda**

As per the decision of the 94th meeting of the MPEDA and subsequent financial sanction vide AQ/HO/BHN-3/2001/140 dated 30/4/2001, a one day Seminar was organized by the Regional office of MPEDA, Bhubaneswar on "Sustainable shrimp & prawn culture in Orissa" on 29-5-2001 at Hotel Quality Inn Crown, Bhubaneswar.

Mr. Prabhat Samantray, Member of Parliament and Member, MPEDA presided over the Seminar, while Mr. D.P. Bagchi, IAS, Chief Secretary to Government of Orissa was the Chief guest. Mr. K. Jose Cyriac, IAS. Chairman, MPEDA, delivered the keynote address. Mr. P.K. Das, IAS, Director, Ministry of Commerce & Industry, Govt. of India, Mr. Jagadananda Panda, IAS, Revenue Divisional Commissioner (SD), Ganjam, and Mr. G.K. Dhal, IAS, Director of Fisheries, Orissa, graced the occasion as guests of honour. Nearly 130 delegates comprising Shrimp and Prawn Farmers, Hatchery Owners, Seafood Exporters, and officials from the State Fisheries Department, State Pollution Control Board, Banks, NABARD, Puri Unit of CIBA, Fisheries College, Rangailunda etc. participated in the Seminar.

Dr. G. Santhanakrishnan, Joint Director (Aqua), MPEDA, welcomed the dignitaries and the delegates. He also gave a brief background of the development in shrimp culture sector that had taken place in the State during the last two decades. The Inaugural Lamp was lighted by Mr. Prabhat Samantray and other dignitaries on the dais.

Mr. Prabhat Samantray M.P. inaugurating the Seminar by lighting lamp.



Mr. D.P. Bagchi I.A.S, Chief Secretary, Orissa speaking at the Seminar

Mr. K. Jose Cyriac I.A.S, Chairman, M.P.E.D.A delivering key note address.

View of the Audience

The Chairman, MPEDA, in his key note address, gave an account of the country's seafood export performance

and the increasing contribution to the export endeavour from aquaculture sector. He emphasised the importance of freshwater Prawn farming in Orissa considering the vast freshwater resource potential available in the State. He also underscored the importance of environmental aspects while implementing developmental activities.

Mr. A.K. Samantray, Deputy Director of Fisheries (SBW), Orissa, spoke on 'Status of Shrimp Culture in Orissa' giving, details of the developments since inception. While giving details of area developed and the farmers involved, he spoke on the applications filed with the District/ State Level Committees addressed to Aquaculture Authority for Licenses and on pending cases with the Authority. Mr. Sanjay K Mohanty, President, Orissa Shrimp Farmers Association delivered a talk on the problems encountered by the shrimp farmers of Orissa. One of the problems mentioned was the burden of sales tax on shrimp seeds imposed on farmers and he pleaded for withdrawal of the levy as it had pushed up losses. He suggested the introduction of a land lease policy to prevent unauthorized encroachments and destruction of mangrove forests. He also suggested the upgradation of the shrimp culture technology and constitution of an interim committee to control disease incidence among cultured shrimp Mr. S.K.Sahoo, Deputy Director of Fisheries (Central Zone) presented the status paper on freshwater prawn culture in Orissa. Mr. Sai Ram Singh, a leading freshwater prawn farmer from Andhra Pradesh told the delegates about the major development that had taken place in the State in respect of Scampi Culture, with focus on his experiences in the past ten years in freshwater prawn culture in Nellore district of the State.

The Chief Secretary to Govt. of Orissa highlighted the importance of sustainable production. He declared that an Aquaculture Advisory Committee headed by the Director of Fisheries, Orissa would be formed and that this committee would meet once in every three months to sort out problems faced by the Shrimp / Prawn farmers and exporters of the State. He also told the participants about the constitution of a Task Force under the Chairmanship of the State Agriculture Production Commissioner to regulate and coordinate the activities of freshwater and brackishwater aquaculture and also to look into Coastal Zone Management Plan. The MPEDA and the representatives of the concerned Association were represented in the AAC and the Task Force. He asked the Director of Fisheries to clear all pending applications for Aquaculture Authority License within 15 days. He emphasized the need for an independent Ministry for Fisheries.

The RDC, Ganjam spoke regarding the delay in the issuance of License by the Aquaculture Authority. He emphasized the need for ensuring quality standards for shrimp and prawn seeds. The Director, Ministry of Commerce, Govt. of India spoke on the supportive role of the Ministry of Commerce to improve productivity and quality through various agencies. He dealt with the existing and proposed incentive schemes of the Ministry viz., quality checking of shrimp seeds, on-farm chilled room facility etc. He offered all possible support for increasing aqua production and export.

Mr. Prabhat Samantray, M.P., in his presidential address stated that shrimp production in Orissa was very low and not consistent with the coastline of 480 km. of the State. He advised that all efforts should be made to harness the vast potential the State possessed in a manner that would generate employment in the rural sector besides increasing the exportable production. He underscored the need for renovation of the saline embankments in the coastal belt to protect the farms from cyclone. He wanted that the beneficiaries for the Shrimp Farm Project developed with World Bank aid at Jagatjore should take up shrimp culture in an enduring manner for which necessary technical/financial assistance should be provided. He wanted that the freshwater resources should be utilized for prawn production. He advised the Association and the State Fisheries Department to get the information on sales tax levied by other states so that he could discuss the matter with the Chief Minister.

The forenoon session was concluded with vote of thanks by Mr. B.C. Behera, Deputy Director, MPEDA, Bhubaneswar.

The entire afternoon session was devoted to discussion on the presentations made earlier. Mr. Prabhat Samantray keenly listened to the problems of farmers. Most of the discussions were focused at the development strategies for scampi culture in the State taking the cue from the farmers of the experiences of the neighbouring Andhra Pradesh. Shrimp farmers demanded that MPEDA could establish a Scampi hatchery in the state. They complained on the low price being offered for farm raised shrimps and pointed out the purchase tax was discouraging outside buyers to come to the State. Shrimp farmers also complained about the delay in getting the licenses from the Aquaculture Authority. As emerged from the deliberations, the main bottlenecks in shrimp production were non availability of quality hatchery seeds of shrimp and scampi. The first scampi hatchery is yet to be set up in the State, they said.

The Chairman summerised the discussions of the day and advised the Director of Fisheries to take up the matter of expediting issuance of Aquaculture Authority licenses. He also advised that the Insurance Companies should revive the crop insurance scheme soon. He asked the promotional agencies to increase the number of training programmes for the farmers. He was thankful that the MPEDA could organize the Seminar, which was quite essential and long due.

Dr. G.Gopakumar, Asst. Director (Aqua), MPEDA, Bhubaneswar proposed a vote of thanks.

ERRATUM

Vol 21 No. 3 (June 2001) issue of Fishing Chimes.

Karnataka Newsletter, Page 48.

In the upper portion of the running matter in col. 2 and 3 on this page there are two photographs. The first one is that of Mr. D.M. Abdul Hameed and the second one is that of Dr. K.V. Devaraj. Inadvertantly the captions got reversed. The error is regretted.

West Bengal News Letter

From **P.K.Samanta**

Kironmoy Nanda joins State Cabinet as Fisheries Minister for the Sixth Term

By holding the portfolio of fisheries for the sixth time in succession in West Bengal cabinet Mr. Kironmoy Nanda appears to have created a global record. It is doubtful whether there is any nation or a State in a nation having the same politician elected as Fisheries Minister in succession for the sixth time. Fisheries Ministers from other States of India need to learn lesson to be as successful in fisheries development as Mr. Nanda who continues to function with a renewed interest and a fortified vision and zeal. As the first priority, he is paying focal attention on his pre-anounced Rs. 10 crore fishery infrastructure project at Digha, Midnapur. He plans to upgrade traditional boats to extend their operations through mechanisation/ motorisation with government funds.

The project at Digha to develop infrastructure to produce dry fish will be jointly funded by the National Co-operative Development Corporation (NCDC) and the State Government. He expects that the project will be completed within a year. Nanda has said that fishermen would be trained in modern fishing techniques. He has exhorted the fishermen to avail of the new facilities by forming Co-operatives. According to him, the project is the first of its kind in India.

Nanda is highly critical of the existing method of producing dry fish. He says that it is not scientific and is inconvenient to the producer. Under the project taken up, he feels that both the quantity and quality of the product would be upgraded. Of course, he is very hopeful of a huge market for dry fish both for domestic sales as well as exports. He admits his failure to fulfill the promise given to fishermen to provide radio-telephones in fishing vessels, for which he blames non-cooperation from the centre. He rates his department's performance very high. According to Nanda, the achievement in the fisheries sector in West Bengal is the best in the country which has earned the credit of winning the National award for four consecutive years.

Remarkable Achievement of Mudiali Fishermen's Co-operative Society (MFCS) in North 24-parganas, West Bengal.

Years of hard work and painstaking struggle by the fisher members of the Mudiali Fishermen's Co-operative Society (MFCS) have earned all-round success and gainfull achievement in sewage-fed freshwater fish production through polyculture. The MFCS is utilising industrial waste and sewage for fertilising fish tanks for augmenting production of a major carps such as Rohu, Silver carp, Spotted pighead, Common carp, Prawn etc.

By tracing the history of its development, it is found that gradual transformation of the age old marshland of 1940s where fishermen from lower Damodar region settled and took up fishing, the place, later on got reduced in area and was ultimately converted into its present state of a fishery as a nature park covering more than 60 hectares. Embankments cover only ten hectares and nine waterbodies account for the rest, where 400 kg of fish is caught everyday from this wasteland fishery. The source of water is the Sonarpur canal that carries waste from industrial units in Hyde Road, Garden Reach, Metiabruze and Taltala. In this wasteland fishery, 35 million litres of waste (70% industrial and 30% domestic) stored is allowed to settle in the first two tanks for about 3 weeks from where, after siltation, it is allowed to overflow into the next tank. The entire water flow is controlled by a 1200 ft. channel divided into six sectors, all of which are very deep so that slush settles down comfortably. To augment better filtration of polluted water, weeds, chinese grass and other necessary devices have been built to help siltation as water passes through and get naturally filtered. Another canal has guppy fish which eats trash, plankton and lime, reducing the acid involved in horticulture activity in a meaningful way. Obviously, they have planted water hyacinth whose roots absorb metal traces in water, *Leptoplea chinensis* which absorbs oil, subabul, a leguminous tree whose roots help in nitrogen fixation in soil, trees from the Acacia group, whose fruits have an alkaline effect similar to lime. The MFCS now boasts of more than 5,00,000 trees of 200 varieties which 32 spotted deer and birds like the painted stork egrets and cormorants use as their home. In winter season, the vast waterbodies of this wasteland fishery also attract about 120 variety of birds.

Mr. Ashok Patra, Vice-Chairman MRCS expects that the turn-over may touch Rs.60 lakhs in the current year. In the past two years, the fish production was badly affected because of floods and management problems. A total number of 101 Committee members and 120 staff work on a no-work-no-pay basis and their daily wages range from Rs.35 to Rs.71 only.

Due to this remarkable and gainful achievement the MFCS won the National Productivity Council Award three times and several other awards at the Horticulture Society exhibitions. Teams from Japan, Norway and Srilanka have come here to study this unique project and it now occupies a glorious position in the fish production activity in the State. It now inspires the East Calcutta Fisheries on EM Bye Pass.

ISI's Research Work on Fish Indicators for Fishermen in the Digha-Talsari-Shankarpur Region in West Bengal

In Kolkata, Scientists of the Indian Statistical Institute (I.S.I) are carrying out at present considerable research on Fish Indicators in the Digha-Talsari-Shankarpur region of Midnapur District, West Bengal. The research work is based on a mathematical model to caution fishermen against catching these fishes which get contaminated by water plant toxins. Under the fold of mathematical biology (collaboration of biology with

mathematics), scientists are trying to solve more complex problems which are beyond experimental approach but enable different physiological functions to be explained through mathematical modelling.

Govt's efforts to remove illegal Fisheries (Bheri) from Major Riverbeds in Bangoan and Basirhat areas

By unusual encroachments and construction of earthen dams on the major riverbeds in Bongaon and Basirhat area of North 24-parganas, some CPI-M sympathisers and politicians are running illegal Bheri fisheries and brick kiln business. In fact the fishery dams obstruct the normal flow of water in the river forcing the water to seek other often devastating routes of escape, when the river is in spate and thereby regularly causing flood havoc in the region. Unfortunately, the government remained indifferent thereby mysteriously safeguarding the interest of the vested quarters. The situation radically took a serious turn when a devastating flood occured about few months back and damaged the life and property of the people of North 24-Parganas district. After installation of the New State Cabinet in May, 2001 the left Front Government has taken up the matter seriously to clear up the passage of the waterways from the river Ichamati, Jamuna, Bidyadhari, Padmakhal etc. where there are 200 illegal Bheri Fisheries and 84 brick fields. Of such brick fields and Bheri Fisheries the various structures are acting as the potential threat to the normal flow of river during the monsoon, causing floods in the areas that did not suffer in the past. Under the situation, even the Sunderban estuary has been affected by the erratic flow of water down to the sea. The state government under the leadership of Finance Minister Mr. Ashim Dasgupta, held discussions with the North 24-Parganas District Police and Civil Administration as well as Ministers from the Irrigation Dept.. (Irrigation Minister Mr. Amal Roy and Relief Minister Hafiz Alam Sairani) and has taken decision to get rid of the fishery dams and the brick kilns and promised to carryout the drive ruthlessly and without prejudice. The drive is expected to lead to the completion of the job within a fortnight. Further, the government is expected to keep a strict watch so that they do not a make a comeback. It has been pointed out in the meeting Mr. Dasgupta had with the Chief Minister recently, a decision was taken that a handful of people should not be allowed to make gain at the cost of lakhs of people getting affected during floods.

An employee of irrigation and waterways assigned for supervising the operation at Bibhuti Bhusan Ghat disclosed that they could not touch those fisheries controlled by C.P.I.(M) leaders but could only manage to remove water hyacinths and small obstructions from the river bed. Mr. Phani Chakraborty, a farmer at Sarahati told that people had urged the administration, times without number, to take radical steps in Bongaon but nothing had been done because fishery owners are believed to be buying protection from a local political leader who safeguarded their interests. The local people who assembled on the bank of the river to watch the cleaning operation witnessed that the police acted as idle spectators as they could not touch the fisheries of vested interests.

On 1st June, State Govt. Staff had demolished few illegal brick kilns and fisheries in Bongaon and Bashirhat areas of North 24-parganas but they have kept the matter in abeyance later, because of intra-party conflict on this issue.

Mr. Ajoy Bhattacharjee, Addl. District Magistrate, North 24-parganas said that the District Administration had already started a demolition drive at these points in Bangaon. These included Sarhati Bridge to Parmadhan Ghat, Parmadan Ghat to Mahandan para and Mahandar para to Bhibhuti Bhusan Ghat.

SHRIMP 2001 CHENNAI, INDIA

After a long lapse, the Global Shrimp Industry will once again be meeting on 27-29 September 2001 in Chennai, India. The meeting, the Fourth World Conference on Shrimp Industry and Trade, organized by INFOFISH in collaboration with FAO-GLOBEFISH, the Marine Products Export Development Authority of India (MPEDA) and the Seafood Exporters Association of India (SEAI), will be held at Hotel Le Meridien, Chennai. The three day programme includes a Technical and Investment session and a Buyer-Seller Meet. The event offers opportunities for buyers and sellers to meet and exchange ideas and promote their respective interests.

Seventeenth in the series of International Fishery Commodity Conferences of INFOFISH, SHRIMP 2001 will examine the present global scenario and the future outlook. The event will be addressed by over 37 speakers in the four main sessions and the Technical and Investment session. Session I will focus on the Global Overview with a closer examination of the Global Shrimp Supply Situation while Industry Situation and Outlook (8 speakers) will be focused on in Session II.

The principal markets including Japan, US, Europe and beyond will be examined in Session III dealing with Markets and Marketing (9 speakers). Session IV on Technological Aspects of Production, Processing and Quality Assurance (7 speakers) will look at some topical issues in these areas with discussions on a wide range of issues such as quality and HACCP, value-addition, disease management, eco-labelling etc.

Each session will be followed by a panel discussion. The Technical and Investment Session on Day 2 afternoon and Day 3 morning will be addressed by over 10 specialists and industry leaders. A Buyer-Seller Meet is scheduled for Day 3 morning. Post conference tours to two major shrimp landing and processing centers in the shrimp aquaculture belt of India, Tamil Nadu and Andhra Pradesh will be arranged. All in all, an exciting, interesting and informative programme awaits delegates of SHRIMP 2001 CHENNAI.

For further information please contact

INFOFISH
POB 10899
50728 Kuala Lumpur
Malaysia
Tel (603) 2691 4466
Fax (603) 2691 6804
Email infish@po.jaring.my
Website www.infofish.org

VM/VM/92/2001

R.N. 37750/81